1. Projections of megafire probabilities over the continental United States using weather and climate forcing

Presenter: *Barbero, PhD, Renaud, Post-doc, University of Idaho*
Additional Author(s):
Abatzoglou, John, Assistant Professor, University of Idaho
Kolden, Crystal, Assistant Professor, University of Idaho

Increased wildfire activity in recent decades has been partially attributed to changes in atmospheric conditions conducive to fire spread. Increases in very large fires have also been observed in recent decades and are important contributors to area burned as well as having impacts on ecosystems, air quality and fire suppression resources. Empirical generalized linear models were developed to model the largest 5% of MTBS fires (>10kha) over the 1984-2010 period across ecoregions at a half-degree grid at weekly timescales using antecedent and concurrent weather and climate forcings. We considered two set of model, one based on meteorological predictors while the second set includes more comprehensive fire danger predictors. The results show that in general, Energy Release Component (relative humidity) was the best predictor of megafire weeks in the fire danger (meteorological) models in most ecosystems. A combination of fuel accumulation associated with anomalously wet conditions in the previous growing season and synoptic patterns promoting high fire weather were significant predictors of megafires in rangelands, while long-term drought was a significant predictor in climate-limited ecoregions. The results also show that models using fire danger predictors were more skillful than models using meteorological variables alone. We then project megafire probabilities for the mid-21st century (2041-2070) using an ensemble of downscaled climate projections from CMIP5 climate models. These projections are compared to probabilities simulated over the historical time period to highlight geographic areas of significant change.

Keywords: large fires, weather, climate, climate change

Bio: Renaud is currently a postdoctoral researcher at the University of Idaho with a background in climatology. Most of his work is focused on the mechanisms underlying climate variability and fire activity. His current research is on the relationships between very large fires, weather and climate in the United States but he is also working on Santa Ana winds and their involvement in wildfires in Southern California.

1.1 Atmospheric drivers of daily variations in fire growth of very large wildfires

Presenter: *Abatzoglou, John, Assistant Professor of Geography, University of Idaho*
Additional Author(s):
Barbero, Renaud, Postdoctoral Fellow, University of Idaho
Kolden, Crystal, Assistant Professor of Geography, University of Idaho
Larkin, Narasimhan, Research Scientist, USFS Air Fire Team
Stocks, Brian, Research Scientist, Canadian Forest Service
Mike Wotton, Research Scientist, Natural Resources Canada, Canadian Forest Service

The daily progression of very large fires is of keen interest to a variety of stakeholders; resolving the biophysical and human factors contributing to so-called ‘fire runs’ is of particular importance due to the

high number of structure losses associated with these events. In this analysis we focus on atmospheric forcing and its influence on fuel availability and fire spread during daily large fire runs. Whereas prior case studies have implicated specific meteorological factors in large fire runs, we aim to identify common factors associated with large fire runs across a broader sample. We examine relationships between daily burned area and both fire danger metrics and meteorological variables for more than 6,000 recent large wildfires (>202ha) that occurred from 2003-2010. Daily burned area from these fires was obtained from SmartFire v2 and further classified into very large fires (>10kha) and other large fires (<10kha). While the largest fires tended to occur in concert with optimal antecedent climatic conditions, day-to-day variations in fire growth cannot be explicitly explained using low-frequency information. To overcome this limitation, intra-fire relationships between daily fire growth and both meteorological and fire danger indices were examined for very large fires. The top 20 percent of daily fire runs coincided with significantly lower fuel moisture and elevated fire danger when compared to days with lesser growth. These signals were particularly apparent across Northwestern Forested Mountains, Mediterranean California and Cold Desert ecoregions of the western United States. In addition, we highlight a regional example of distinct drivers of large fire growth days in southern California associated with very large summer wildfires in contrast to very large wildfires in autumn coinciding with Santa Ana winds. This example elucidates contrasting meteorological processes that contribute to two distinct fire regimes.

Keywords: fire growth, meteorology, climate, fire danger

Bio: John conducts climate related research specific to western North America and is engaged in several aspects of applied climatology and meteorology specific to hydrology, wildfire and agriculture. John's research portfolio includes better sources of climate variability and regional projections of climate change and associated impacts across the western United States.

2. Landscape-scale patterns of fire and drought in eight High Plains states, USA

Presenter: *Ford, PhD, Paulette, Research Ecologist, USDA Forest Service, Rocky Mountain Research Station*

We examine 33 years (1980-2012) of temperature, precipitation and natural Federal wildfire occurrence data to determine landscape-scale patterns of drought and fire on the southern and central High Plains of the western United States under a changing climate. These High Plains states are in the midst of ongoing extreme drought, experiencing below normal precipitation and above normal temperatures for the past several years. Drought is expected to persist or intensify. In addition, climate change is predicted to have multiple effects on fire regimes. Our goal is to relate the frequency and size of wildfires to a precipitation, temperature and latitudinal gradient to increase understanding of fire and drought interactions on the Great Plains in the face of climate change. Annual and seasonal climate trends were quantified between 1980 and 2012 for the High Plains EPA Ecoregion using the temporal Parameter-elevation Regressions on Independent Slopes Model (PRISM) climate model datasets. Linear trends were fitted to each pixel to develop the slope, or rate of change through time for annual average precipitation, minimum, maximum, and average temperature. Changes in fire frequency and size were tested with Poisson and normal GEE models respectively including autoregressive errors and offsets for exposed land by state.
Preliminary results indicate average annual precipitation decreased across the High Plains study area by 2.8 mm yr-1(+/- 1.3 mm), and was especially pronounced during the period of June, July and August.

Annual average maximum temperature increased by 0.03° C yr-1(+/- 0.015 °C), while minimum and average temperatures remained relatively unchanged. Approximately 61,000 natural wildfires on Federal and Tribal lands occurred in the 8 states from 1980 to 2012 (roughly 10% were High Plains wildfires). Overall there was a significant increase in number of fires from 1980 until circa 2005. After 2005 there was a slight decrease or leveling off in the number of fires. Total acres burned increased until 1991-92, and then acres burned plateaued until 2007, when it began to increase again. On average there does appear to be a significant increase in total acres burned over the entire 33 years. Results point to trends in reduced precipitation and increased temperatures, with more and larger fires in the region over the last three decades. Our results will be used to improve predictive forecasts of fire in the Great Plains, which are currently prone to uncertainties related to climate projections and a paucity of information on grassland fire-climate relationships.

Bio: Paulette L. Ford is a Research Ecologist with the USDA Forest Service, Rocky Mountain Research Station in Albuquerque, New Mexico. She received her M.S. in Biology from the University of New Mexico, and her Ph.D. in Renewable Natural Resources Studies and Ecology and Evolutionary Biology from the University of Arizona. Her interests include the role of disturbance (fire and drought) in structuring grassland, shrubland and desert communities. Paulette's long-term (18-year) research uses an experimental framework to analyze the effects of season and frequency of fire on shortgrass steppe under a changing climate.

3. Intraspecific variation in climate- and fire-related functional traits among northwestern California tree species: a preliminary analysis

Presenter: *Johnston, Kayla, Humboldt State University*

Functional trait variability determines the extent of a species' climate and disturbance tolerance and, therefore, its geographic range. I predict that a species existing over more variable climate and fire regime conditions will have larger variability in functional traits. Shore pine (Pinus contorta var. contorta), Sitka spruce (Picea sitchensis), and coast redwood (Sequoia sempervirens) each have distinct strategies, yet coexist under similar climate conditions in portions of their range along the north coast of California. Shore pine is short-statured (6-15 m), short-lived (<200 years), shade intolerant, and minimally fire resistant. Sitka spruce is tall (40-55 m), long-lived (>800 years), shade tolerant, and very fire sensitive. Coast redwood is the tallest tree in the world (>60 m), very long-lived (up to 2,200 years), shade tolerant, and very fire resistant. Specific leaf area, maximum crown height, wood density, bark thickness, and litter flammability are measured as functional traits that represent strategies for existing in particular climate and fire regimes. As a result, I have quantified the amount of variation and distributional properties for each trait of each species and analyzed whether the amount of variation in each of these traits differs among species using ANOVA. The variation of these traits will provide information that will inform model developments to determine future species distribution and coexistence under projected climate conditions.

Keywords: Sitka spruce, shore pine, redwood, climate, fire, tree traits, plant strategies

Bio: Kayla Johnston is an Oregon coast native and is currently a graduate student at Humboldt State University working with Dr. Jeffrey Kane. She enjoys studying general ecology, particularly forest ecology and fire ecology. Her favorite tree species is whitebark pine, which she fell in love with at Crater Lake

National Park, OR. Outside of studying, Kayla prefers to be outdoors running, hiking, or socializing with dogs, but can also be found indoors baking, cooking, or sewing.

4. Predicting High Severity Fire Occurrence and Area Burned in a Changing Climate for Three Regions in the Western US.

Presenter: *Keyser, Alisa, UC Merced*
Additional Author(s):
Anthony Leroy Westerling
Jeanne Milostan

Research has shown that climate variability drives the occurrence of large fires and is important to predicting fire severity. We found that Western US area burned in high severity fire can be accurately predicted using a generalized Pareto distribution model with covariates of climate, weather, and topography. Our model was robust in all but the most extreme fire years, e.g. 1988, 2000, 2002, and 2003, where area burned in high severity was significantly greater than in other years.
We developed models for the Northern Rocky Mountains, the Sierra Nevada Mountains, and the Southwestern US to determine if regional differences in controls on severity were at play in extreme years. The regional analysis improved model performance by capturing extreme fire years and identified regionally unique covariates. For the Northern Rocky Mountains the addition of elevation and fire regime condition class improved the prediction in extreme years. In the Southwest relative humidity and moisture deficit in the month of fire were critical to capturing extreme fire years. The Sierra Nevada model had the most complex set of covariates that included: moisture deficit, evapotranspiration, precipitation, and fire regime condition class. By incorporating regionally specific variables, our models were robust in prediction of high severity area burned in all years.
For this work, we applied high CO2 emission scenarios from three general circulation models to our regional statistical models to predict area burned in high severity for the period 1953-2099. We used the downscaled climate as an input into the VIC hydrologic model to generate independent variable sets for each future scenario. Initial results for analogous pixels in the Northern Rockies and Southwest exhibit very different responses to similar changes in climate. We will present potential changes in the annual area burned in high severity fire under future climate as well as areas where the probable occurrence of high severity fires might increase for three study regions.

Bio: Alisa Keyser is a Ph.D. candidate in Environmental Systems at the University of California Merced. She received her M.Sc. in Forestry from the University of Montana.

5. Assessing Lebanon's wildfire potential in association with current and future climatic conditions

Presenter: *McWethy, David, PhD, Assistant Research Professor, Montana State University*
Additional Author(s):
Jazi, Mireille, Assistant Instructor, University of Balamand

The increasing occurrence and extent of relatively large-scale wildfires have contributed to the severe degradation of Lebanon's forests during the past decade. Extended periods of warm and dry weather are promoting fire spread. Additionally, extreme precipitation events coupled with forest dieback are resulting in flooding and loss of soils through mass-wasting. We examined past fire activity and climate conditions and trends in climate conditions to project future wildfire conditions in Lebanon. Our specific

objectives were to 1) generate a wildfire potential index for current climatic conditions and evaluate this index with an observed estimate of wildfire risk, 2) generate the same wildfire potential index for future climatic conditions, and 3) compare between current and future wildfire potential indices.
The Keetch-Byram Drought Index (KBDI) was the primary climate variable used in our evaluation of climate/fire interactions and conditions. The KBDI is a cumulative estimate of wildfire potential based on meteorological input parameters and an empirical approximation for moisture depletion in the upper soil and surface litter levels. The spatial climatic data needed to calculate KBDI were mostly obtained from observed, interpolated data or simulated Global Climate Models (GCM) for current and projected climatic conditions. Datasets of current averages (1950 - 2000) and future 30-year running averages (2010 - 2039) included: monthly maximum temperature, monthly precipitation and mean annual rainfall at a 1 km of spatial resolution.

The quality and performance of the calculated monthly KBDI values was evaluated. A comparison between the average monthly values (2006-2010) of the Fire Weather Index (FWI) for Eastern Mediterranean and the monthly KBDI average values for Lebanon showed a strong correlation, indicating increasing wildfire potential between March and September. The comparison between the relative areas of current and future wildfire potentials showed a significant increase in KBDI values (more than 50) affecting a total area of 1143 km2. At the same time, only 442 km2 were affected by a significant decrease in KBDI values (more than -50). Although the scale of the study area is very small compared to that of other countries in the region, this study provides preliminary results indicating the potential for an increasing risk of severe and large-scale wildfires in the Eastern Mediterranean.

Keywords: Wildfire potential, climate change, downscaled global climate models, Keetch-Byram Drought Index

Bio: David McWethy is an Assistant Research Professor in the Department of Earth Sciences, Montana State University. His research centers on how past and present human and natural disturbances shape vegetation and influence the structure and function of ecosystems.

6. Assessing impacts of climate change and human population growth on forest fire potential in the tropics: A case study of the Tain II Forest Reserve in Ghana

Presenter: *Osei-Kwarteng, Eric, student, Kwame Nkrumah University of Science and Technology*

The increase in human population pressure especially in forest fringe communities and the accelerated change of land use in tropical vegetations i.e. conversion of forested ecosystems into farming and pastoral ecosystems have led to an increase in the use of fire. While certain tropical dry forests and savannahs have been adapted to anthropogenic fire use over the years and show typical features of sustainable fire ecosystems, the opening and fragmentation of tropical evergreen forests has increased the risk of wildfires and this has destructive impacts on biodiversity and sustainability of these forest ecosystems. An assessment of potential impacts of climate change on fire regimes in the Tain II Forest Reserve of Ghana was carried out using the GCMs and a GCM derived lightning model (Goldammer and Price, 1997). Impacts of human population increase on forest fire potential in and around the forest reserve was also undertaken through the use of primary and secondary data sources. Primary data was obtained through interviews of community members and other stakeholders with the use of semi-structured questionnaires, field observations and focus group discussions. Secondary data was also obtained from existing literature relevant to the study. Considering the potential impacts of climate

change on fire regimes in the Tain II Forest Reserve, the study concluded that, there is a high degree of certainty that land use and climate features under conditions of a 2xCO2 atmosphere will influence fire regimes in the area. In terms of impacts of human population increase on forest fire potential, the study concluded that, the potential for fire to occur in and around the reserve is high due to increased farming and grazing impacts which leads to the formation of open and sparse vegetation cover influencing a high potential for wildfires to occur in and around the reserve. Stakeholders in wildfire management and for that matter climate change issues need to be prepared for managing situations which, in the near future, may require the development of innovative technologies and the preparedness of administrations to accomplish tasks that may differ from today's situation.

Keywords: Forest fire potential

Bio: June, 2014(Expected Degree) - MSc Agroforestry from Kwame Nkrumah University of Science and Technology(KNUST), Kumasi-GHANA
May, 2005 - Bsc Natural Resources Management from KNUST, Kumasi-GHANA

7. The impacts of wildfire on population dynamics of amphibians in northern New Mexico and southern Colorado.

Presenter: *Wright, Molly, Master's Student, New Mexico Highlands University*
Additional Author(s):
Saiz, Justin, Undergraduate Research Assistant, New Mexico Highlands University
Salinas, Steven, Undergraduate Research Assistant, New Mexico Highlands University
Corey-Rivas, Sarah, Visiting Professor of Biology, New Mexico Highlands University
Brown, Sara, Assistant Professor of Forestry, New Mexico Highlands University
Rivas, Jesus, Associate Professor of Biology, New Mexico Highlands University

Climate models suggest that the planet is becoming hotter and drier. As a result, natural disturbance cycles, such as forest fires, have been altered across many ecosystems in the Southwest. Wildfires are becoming increasingly larger and are burning more severely, affecting wildlife habitat, especially amphibian habitat. One of those large forest fires was the Track Fire, which burned 11,247 ha in 2011 on the boarder of New Mexico and Colorado.

The purpose of this study is to understand the impacts of the Track Fire on amphibian population dynamics within northeastern NM and southern CO. We pose the following question: How did the Track Fire impact amphibian population dynamics, vegetation, and water quality? Data was collected by conducting minnow trap deployments, day and night visual surveys, and frog call transects surveys. Additionally, line-point intercept transects were used to measure the changes in vegetation, and analysis of water nutrients was conducted in all three site locations. Our preliminary results suggest that far fewer amphibians are able to survive in the burned area due to a combination of factors, including water quality.

Keywords: Climate change, amphibians, high severity forest fire

Bio: She has lived throughout various parts of United States, worked for the federal government in both fire and wildlife in a variety of different ecosystems. She obtained her undergraduate degree from the University of Guelph in 2010 in Wildlife Biology, and is currently pursuing her Master's at New Mexico

Highland University. Her main career goal is to work with both wildlife and fire, focusing on finding ways to make these two areas of natural resource management work together.

8. The effects of the non-native laurel wilt disease on crown fuels

Presenter: *Bailey, Cody, Graduate Research Assistant, Department of Forestry, Mississippi State University*
Additional Author(s):
J. Morgan Varner

Invasions of non-native insects and pathogens into forest ecosystems have been linked to economic and ecological impacts. A recent non-native species introduction is the redbay ambrosia beetle (Xyleborus glabratus) which transmits a fungal pathogen Raffaelea lauricola responsible for laurel wilt disease (LWD). R. lauricola blocks the xylem of redbay (Persea borbonia) and many other taxa in the Lauraceae family causing wilt symptoms that eventually lead to 90% to 100% tree mortality. Dead redbay leaves are marcescent for one year or more, with very low foliar moisture contents (FMC). Lowered FMC has corresponded to increased crown ignition in several North American trees. FMC changes of 25 redbay trees in northeastern Florida were measured monthly over one calendar year and on three separate days across 24-hours. Highest average FMC values in both asymptomatic (144%) and symptomatic (156%) trees occurred in May, while killed trees peaked in August (33%). FMC in asymptomatic trees were lowest in March (81%), symptomatic in February (64%), and dead in January (7%). This study began with 15 asymptomatic and 10 dead trees; by the end of the year of observation 11 asymptomatic trees (73%) had been killed by LWD. Trees killed by LWD had the lowest FMC in afternoons (1600 h) in March, July, and October. The highest FMC was recorded in the morning (0800 h) in March and July, and late evening (2200 h) in October. Attached dead leaves had substantial diel variation, ranging from 6 to 25% FMC. This research has implications for the management and better understanding of LWD and for other non-native and fire interactions in forests elsewhere.

Keywords: foliar moisture content, redbay ambrosia beetle, crown fire, non-native, invasive species

Bio: Cody D. Bailey is from central Illinois and received his B.S. degree in forestry from Southern Illinois University Carbondale. He is currently completing a M.S. degree in forestry from Mississippi State University with research interest in disturbance ecology, fire-pathogen interactions, and forest ecology. He is a member of the Society of American Foresters, Xi Sigma Pi, and the founder of the Mississippi State chapter of the Student Association for Fire Ecology.

9. Clearing distances for power and communications infrastructure

Presenter: *Butler, Bret, US Forest Service*
Additional Author(s):
Hogge, Joseph, Ph.D. Candidate, Brigham Young University

Wildland fires can damage power and telecommunication infrastructure. Companies that maintain the equipment and managers responsible for the property on which the equipment is located are interested in managing vegetation to minimize fire caused damage. Vegetation clearance standards in the US have been specified primarily from the standpoint of preventing ignition due to arcing from the power line to ground or vegetation, rather than preventing thermal damage caused by fire burning nearby vegetation.

Two recent studies performed preliminary analysis of vegetation clearance required to protect such equipment. Combined the studies considered steel, wood, aluminum, and fiberglass poles and towers as well as overhead insulated and bare conductors. The results suggest that steel towers provide the greatest resistance to fire damage, wood and aluminum structures are similar unless the wood is aged and provides fissures for ember accumulation. Fiberglass towers and poles appear similar to wood, but additional analysis is required. There is evidence from the simulations that the possibility exists for conductors to fail although such occurrence has not been observed. Transformer and junction enclosures are less susceptible to damage primarily due to the steel exterior material. Clearance around microwave towers is dependent on the exposure of cables, guy wires, and other materials. Detailed clearance distances are presented.

Bio: Bret is a Research Scientist with the Missoula Fire Sciences Laboratory. He has been working to understand energy transfer in wildland fire for more than 20 years.

10. Coincident Ground, Airborne, and Satellite Measurements of Fire Radiated Power

Presenter: *Dickinson, Matthew, Research Ecologist, US Forest Service, Northern Research Station*
Additional Author(s):
Hudak, Andrew, US Forest Service Rocky Mountain Research Station, Forestry Sciences Laboratory
Zajkowski, Thomas, Institute for Transportation Research and Education, North Carolina State University
Loudermilk, Louise, US Forest Service, Center for Forest Disturbance Science, Southern Research Center
Schroeder, Wilfrid, Department of Geographical Sciences, University of Maryland
Ellison, Luke, Science Systems and Applications, Inc.
Kremens, Robert L., Rochester Institute of Technology, Center for Imaging Science

Radiation is one of the most useful targets for wildland fire measurement because it can be measured at a wide range of spatial extents and resolutions and relates directly to the combustion process. Comparing ground, airborne, and satellite measurements of fire radiation provides a means of cross-validating measurements and developing an understanding of the limitations of different methods. Coincident measurements of whole-fire radiative power (MW) were made on small (2 ha) and large (>250 ha) burn units during the Prescribed Fire Combustion and Atmospheric Dynamics Research (RxCADRE) project. For large units, fire power estimates were generated from two satellite-borne instruments (the Suomi-National Polar-orbiting Partnership Visible Infrared Imaging Radiometer Suite [S-NPP/VIIRS] and the Moderate-resolution Imaging Spectro-radiometer [MODIS]) and compared with fire power derived from infrared imagery collected by the Wildfire Airborne Sensor Platform (WASP) flown on a piloted aircraft. On small burns, fire power measurements from a longwave infrared camera (FLIR) mounted on a lift were compared with estimates derived from imagery captured from an orbiting Remotely Piloted Aircraft System (RPAS, also known as an Unmanned Aircraft System). In the RPAS method, flame-front perimeters derived from RPAS imagery were multiplied by power per unit length of flame front estimated from single-pixel, tower-mounted radiometers under which fires spread. For one small burn, FLIR, RPAS, and S-NPP/VIIRS measurements were coincident, providing power estimates of 7.3, 7.8, and 8.0 MW, respectively. A time-series analysis showed that measurements from different platforms would have to be made within 1 minute of each other on small burns to be significantly correlated while 10 minutes is acceptable for large burns. Measurement challenges, limitations, and development needs are discussed.

Keywords: fire radiative power, RxCADRE, satellite measurements, MODIS, S-NPP/VIIRS, Remotely Piloted Aircraft System, radiometer, FLIR

Bio: Matthew is a Research Ecologist with the US Forest Service's Northern Research Station. His research focus is the interface between fire science and ecology leading to collaborations with physical scientists, engineers, remote-sensing experts and other ecologists. Past work has included assessment of the risk of prescribed burning to an endangered bat species, development of models for predicting tree injury and mortality, and development of in-fire and airborne measurement methods.

11. Fire Behavior Assessment Team (FBAT) - Measurements from Active Wildfires

Presenter: *Ewell, Carol, Ecologist, U.S. Forest Service*
Additional Author(s):
Reiner, Alicia L., Fire Ecologist, USFS AMSET
Vaillant, Nicole M., Fire Ecologist, USFS WWETAC
Dickinson, Matthew B., Research Ecologist, USFS Northern Research Station
Fites-Kaufman, Josephine, Planning Ecologist, USFS PSW Region

Fire behavior and effects models are frequently used in research and to inform fire and land management decisions despite a distinct lack of field measurements and evaluation data, particularly from active wildfires. The Adaptive Management Services Enterprise Team (AMSET, USFS) coordinates a module focused on the collection of fire behavior data on wildland fire incidents, called the Fire Behavior Assessment Team (FBAT). In collaboration with land managers and interested research groups, the primary FBAT goals are to: 1) measure fire behavior and effects and their relationship to pre-fire fuels, fire history, and fuels treatments, 2) provide data and video useful for improving firefighter safety and public information, 3) build a dataset useful for calibrating consumption, smoke production, and fire behavior and fire effects models, and 4) measure fire effects on archeological, botanical, and biological values. This poster outlines current data collection methods and collected variables and demonstrates the utility of these data for fire managers and scientists.

In coordination with incident management, sampling sites are located opportunistically ahead of fires accounting for current and expected fire behavior, safe access, and fire management tactics. Measurements at each site consist of fuel consumption estimated from fuel inventories and fire weather and behavior derived from heat-resistant equipment left on-site through the fire. We use arrays of thermocouples to estimate fire rate of spread and flame residence time; video imagery to characterize 5-ft wind speeds, flame heights, and general fire behavior; and cup anemometers to measure 5-ft wind speed. Data are collected on canopy, understory, and surface fuels before and after the fire. Fire severity measures are recorded post-fire. Fuel moisture data is often collected prior to the fire. Since the inception of the FBAT module, the full data complement has been collected within 14 wildland fires (98 sites) and several experimental prescribed burns (32 sites) while difficult wildfire conditions have resulted in mixed success on other fires. FBAT data has been used in case studies of fuel treatment effects on wildfire behavior and severity and incorporated in a California project assessing the effects of fire on emissions and fuels consumption. Further conversations with the scientific and fire management communities about methods and uses for FBAT fire behavior and fuels data are expected to lead to their use to improve smoke modeling, assess fire behavior applications, and inform fuel treatment evaluations and planning.

Keywords: fire behavior, wildland fuels, fire management, fuel treatments

Bio: Carol Ewell serves as a fire ecologist with US Forest Service's Adaptive Management Services Enterprise Team (AMSET). She has completed several fuel characterization, treatment effectiveness, and fire severity studies since starting with AMSET in 2003. Prior to that, Carol worked as a fire effects and fire monitor for the National Park Service in CA. Carol uses her experience in fire management along with her academic and ecological background to do strong science knowledge exchange that is useful for land and fire management.

12. Examining Airborne Infrared Fire Detection Data in the Context of Fire Severity

Presenter: *Garrett, Benjamin, Student, University of Montana*
Additional Author(s):
Carl Seielstad
LLoyd Queen

Application of the LANDSAT-based delta-Normalized Burn Ratio (dNBR) for identifying unburned islands within fire perimeters is a subject of interest to ecologists examining vegetation refuges in burned landscapes. However, questions remain as to whether fire actually visited some these refuges but did not trigger change responses in the dNBR. This research integrated forty-one infrared fire detection acquisitions to examine the coincidence of thermal infrared heat detections and dNBR severity classes in the 274 km2 Selway-Bitterroot East Complex of fires (Clearwater National Forest, ID) which burned in 2012. Delta-NBR was imputed using conventional methods from LANDSAT-5 and -8 datasets. Thermal infrared fire detection data were collected by the USDA Forest Service's National Infrared Operations (NIROPS) Phoenix System on 35 days in August and September and detection points were integrated and attributed by date and time to produce a single fire detection point layer spanning the duration of the incident. Although Phoenix data are not calibrated and have variable fire detectability thresholds depending on the amount of fire activity and background temperature, they provide a conservative map of heat locations that does not suffer from errors of commission (e.g, the heat detected is real) and is useful for identifying locations of heat at distinct points in time. For this study, IR detections were compared with dNBR polygons in a GIS. Ten percent of the total fire detections occurred in 'unburned' areas. The proximity of these detections to severity class edges was examined to account for potential spatial incongruities between the datasets as well as areas of sensor saturation (bloom). Further, detections were summarized by severity classes to identify possible relationships between detection frequency and burn severity. These comparisons will serve as an initial framework documenting the efficacy of using LANDSAT-derived dNBR to locate unburned areas within large wildfires.

Keywords: refuge, infrared, nbr, normalized burn ratio, severity

Bio: Benjamin Garrett is a Junior at the University of Montana studying Forest Resource Management. He has an interest in remote sensing of fire and fuels, and is currently working on an undergraduate thesis looking at the efficacy and impacts of fire severity remote sensing techniques.

13. Bushfire Behaviour Predictive Services in Victoria, Australia

Presenter: *Gibos, Kelsy, IMT Fire Behaviour Specialist, Country Fire Authority*

Additional Author(s):
Wells, Timothy, IMT Fire Behaviour Specialist, Country Fire Authority
Slijepcevic, Alen, Deputy Chief Officer Capability & Infrastructure , Country Fire Authority
Fogarty, Liam, Director Knowledge and Engagement Branch, Department of Environment and Primary Industry

The Fire Behaviour Analyst (FBAN) role and skill set is a key component of emergency predictive services for the state of Victoria in Australia. It provides invaluable information for use in bushfire management prevention, readiness, preparedness, response and planning activities. The program initiated in 2006 to fill the void of communicating academically reviewed scientific principles into everyday fire management activities. Since the inception of the training course and incident management team (IMT) role, personnel from multiple fire management agencies have been trained and then successfully contributed products to facilitate tactical and strategic fire risk management decisions. This presentation will illustrate the past, present and future of Victoria's bushfire behaviour predictive services program.

Victoria suffers a history of high loss of life and property related to heavier forest fuel loads and extreme fire weather; although many of the fatalities relate to single large destructive fire events (i.e. Ash Wednesday 1983 and Black Saturday 2009), the quantity of loss is significant (474 civilian lives lost, 32 firefighter lives lost, 6861 houses destroyed between 1901 and 2009). The evolution of fire behaviour prediction tools and services in Victoria provides an interesting account of lessons learnt, success stories and rapid innovation in response to increasing demand in the emergency sector for more consistent, accurate, reliable and defendable decisions under pressure. This presentation will briefly outline the history and development of FBANs in Victoria by examining case studies of their utilization during past incidents. Reflection on the past has led to the development of a suite of currently operational products and services that are regularly generated by Victoria's FBANs. The presentation will provide a snapshot view of the maps, predictive outlooks and tools that Victorian fire managers regularly access. They key bushfire management agencies have recently endorsed a strategy that sets forward the mechanisms to achieve a unified approach to improve the capability and capacity of Victoria's bushfire behaviour predictive services into the future. The strategy sets out the approach for ensuring common needs are identified and met, governance is put into place, joint planning and investment is supported and the capability and capacity of Vitoria's bushfire behaviour predictive services is secure into the future.

Keywords: fire behaviour analyst predictive services

Bio: Kelsy Gibos has a BSc in environmental science and a MSc in Forestry. She has worked for fire agencies overseas including Cantebury, New Zealand and Victoria, Australia. Her main personal interest is in communicating fire science principles and advancements to those who need it most.

14. A Tale of Two Fires – the Relative Effectiveness of Past Wildfires in Mitigating Wildfire Behavior and Effects

Presenter: *Gray, Robert, Fire Ecologist, R.W. Gray Consulting Ltd.*
Additional Author(s):
Prichard, Susan, Research Scientist, University of Washington

The incidence of very large, costly landscape fires in the west is increasing. Landscape fuel treatments, including prescribed fires and managed wildfires, offer a promising approach to mitigating subsequent wildfires. However, we need to better understand how effective landscape burn scars are in mitigating the behavior and severity of subsequent wildfires and how long the treatment effect lasts. Specifically, how effective are wildfire burn scars in mitigating the behavior and effect of future fires, and for how long? Our research focused on two recent fires that encountered past wildfire burn scars but with significantly different outcomes. The >80,000 ha Tripod Complex fires in 2006 in Washington State flanked around, but did not reburn, the 1970 Forks Fire (FF), while the 1,000 ha, 2012 Octopus Mountain Fire (OMF) in Kootenay National Park in British Columbia reburned the 1991 Spar Mountain Fire (SMF). In 2013 we sampled fuels and vegetation in both the Forks Fire and the Octopus Mountain Fire in order to quantify canopy and surface fuel characteristics and elucidate why fire behavior and effects different between the two wildfire events. Due to our low sampling intensity, there was significant variability in fuel loading and vegetation cover between plots and between fires. Fine fuel loads were similar for both fires while large fuel, litter and duff loads were significantly different. Large fuel loading on the OMF plots was almost three times the loading on the FF plots and litter loading was twice that of the FF plots. Duff loading, however, was four times higher on FF plots than on OMF plots. We found significantly higher cover of grasses and forbs on OMF plots than on FF plots but the reverse for shrub cover. Based on the analysis of fuels and vegetation plots, results suggest that OMF reburned the SMF due to a higher surface continuity of fuels (grasses, forbs and litter) and a higher loading of large fuels. With such a small sample size it's difficult to explain with confidence why the Forks Fire did not reburn in 2006, after 42 years since the last fire, but the SMF reburned after only 21 years. From a management perspective, our preliminary results suggest that at around 20 years post-fire, sites with fuelbed characteristics and rates of succession similar to OMF will burn with very high intensity and severity. The dominant variables are likely surface loading of large woody fuels and consistent cover of a flammable substrate.

Keywords: Fire behavior, fire effects, large woody fuels, reburn, burn scar

Bio: Robert W. Gray is an internationally-recognized fire ecologist and owner of R.W. Gray Consulting, Ltd. The firm specializes in fire history, fire behaviour, and fire effects research, fire policy, and fuel treatment effectiveness. Recent initiatives include: fire behaviour/effects analysis research on Parks Canada Agency landscape-scale prescribed burns; wildland-urban interface fuel treatment effectiveness; and, the economics of bioenergy industries as a hazardous fuels solution. Robert's clients include: Parks Canada Agency, US Department of Agriculture, US Department of Interior, The World Bank, and, academia. Robert has served on the board of director's of the Association for Fire Ecology since 2008.

15. Development and Evaluation of the Physics-based WIldland-Urban Interface Fire Dynamics Simulator

Presenter: *Hoffman, PhD, Chad, Assistant Professor Fire Science, Colorado State University*
Additional Author(s):
Mell, William, Research Combustion Engineer, USDA Forest Service Pacific Wildland Fire Sciences Lab
Bova, Anthony, Senior Engineer, CPP Wind Engineering Consultants
Maranghides, Alex, Fire Protection Engineer, National Institute of Standards and Technology Building and Fire Research Laboratory
Weise, David, Research Forester, USDA Forest Service PSW Research Station
Simeoni, Albert, Professor of Fire Safety Engineering, University of Edinburgh
Forney, Glenn, Computer Scientist, National Institute of Standards and Technology.

Given the state of current computer technology, physics-based fire models generally cannot provide simulations wildland fire spread quickly enough for operational use. However, because of their high physical fidelity, due especially to the coupling of fire and atmospheric dynamics and the ability to represent a fuels complex in 3-Diminsions, They can serve a number of purposes within the research community including their use to create "numerical experiments" that can then inform computationally faster, empirically-based models and as a tool to develop new hypotheses regarding fire behavior that can assist in the design of future experiments. WFDS is an open source physics based modeling system that is built upon the structure fire model, FDS, developed by the National Institute of Standards and Technology to evaluate and explore fires behavior across a gradient of wildland and urban fuels. WFDS contains a number of sub-model routines including various ways to represent the fuels complex and various models to account for combustion, fluid dynamics, thermal radiation and convective heat transfer. Here, we discuss completed and ongoing validation efforts of the component models in Wildland-Urban Interface Fire Dynamics Simulator (WFDS) (e.g., radiation) and of the complete model (e.g., fireline behavior). Recent and on-going validation efforts have utilized measurements from both laboratory and field scale experiments.

Keywords: Fire Behavior, Modeling, WFDS

Bio: Chad Hoffman is an assistant professor of fire science at Colorado State University. He received B.S. and M.S. Degrees from Northern Arizona University in Forestry and a PhD. in Forestry from the University of Idaho. His current research focus is on evaluating the role spatial fuel variability on fire behavior and evaluation of physical based fire behavior models. In addition to research he also teaches undergraduate and graduate classes on fire science and fire and fuels management.

16. Vegetation structure of fuel treatments alters fire severity in the wildland-urban interface

Presenter: *Johnson, Morris, Research Fire Ecologist, Pacific Northwest Research Station*
Additional Author(s):
Johnson, Morris, Research Fire Ecologist, PNW Research Station
Kennedy, Maureen, Research Scientist, University of Washington

The 2011 Wallow Fire, largest wildfire in southwestern USA history, burned through thousands of hectares of fuel treatments adjacent to wildland-urban interface communities in eastern Arizona. We quantified fuel treatment performance in changing fuels, fire behavior and fire effects. Thinning treatments significantly changed fuelbed characteristics that facilitate crown fire initiation and spread, and reduced crown fire hazard and severity. Variability in crown scorch significantly differed between untreated areas and treated areas in all three treatment units ($p<0.001$). The distribution of mean crown scorch in the untreated area clustered tightly around 100% for all three units (mean values AP2: 98%, AP6: 98% and NU: 97%), whereas mean crown scorch was lower in the first three treated plots the mean values dropped (AP2: 78%, AP6: 86%. and NU: 92%). Burn severity indices were higher in untreated units compared to treated units. FFE-FVS predicted active crown fire for most untreated plots (AP2: 78%, AP6: 76%. and NU: 100%). Mean torching and crowning indices were lower in untreated plots. This study provides strong quantitative evidence that thinning treatments reduce fire behavior in dry Western forests, even during a fast moving, high intensity wildfire.

Keywords: Fuel treatments, crown scorch, fire hazard, wildfire, urban interface, FFE-FVS

Bio: Morris Johnson is a Research Fire Ecologist at the Pacific Northwest Research Station in Seattle, WA.

17. Fuel treatment prescriptions alter spatial patterns of fire severity around the wildland-urban interface during the Wallow Fire, Arizona, USA

Presenter: *Johnson, Morris, Research Fire Ecologist, Pacific Northwest Research Station*
Additional Author(s):
Kennedy, Maureen, Research Scientist, University of Washington
Johnson, Morris, Research Fire Ecologist, PNW Research Station

Fuel reduction treatments are implemented in the forest surrounding the wildland-urban interface (WUI) to provide defensible space and safe opportunity for the protection of homes during a wildfire. The 2011 Wallow Fire in Arizona USA burned through recently implemented fuel treatments surrounding residential communities in the WUI, and those fuel treatments have been credited with providing firefighter opportunities to protect residences during the fire and thereby preventing the loss of homes that otherwise would have been burned. To characterize the spatial pattern of the fire in the treated area we measured fire severity (crown scorch and bole char) as the fire moved into treated areas from the wildland, then we fit non-linear models to the relationship between each severity metric and distance from the treatment edge in the direction of fire spread. The non-linear curve we chose provides an estimate of the distance into the treated area at which the severity metric is substantially reduced. Fire severity was higher further into the fuel treatment that allowed for clumps of trees and buffers for wildlife habitat than for the fuel treatment that resulted in evenly distributed trees with complete removal of ladder fuels. Crown scorch persisted further into the treated areas than did bole char, which implies that a high intensity surface fire was maintained in the treated areas. All of the fuel treatments we studied in the Wallow fire demonstrated reduced fire severity before encountering residences in the WUI, demonstrating that there are multiple paths to fuel treatment design around the WUI.

Keywords: fuel treatment; environmental management; Wallow fire; wildland-urban interface; spatial analysis

Bio: Morris Johnson is a Research Fire Ecologist at the Pacific Northwest Research Station in Seattle, WA.

18. Pine cones facilitate ignition of forest floor duff

Presenter: *Kreye, PhD, Jesse, Postdoctoral Research Associate, Mississippi State University*
Additional Author(s):
Varner, Morgan, Assistant Professor, Mississippi State University
Dugaw, Christopher, Associate Professor, Humboldt State University
Cao, Jing, Graduate Student, Humboldt State University
Szecsei, Jonathon, Undergraduate Student, Humboldt State University
Engber, Eamon, Fire Ecologist, Redwood National Park

The ignition and combustion of forest floor duff are poorly understood yet have been linked to soil heating and overstory tree mortality in many temperate coniferous forests. Research to date has focused on characteristics of duff that facilitate ignition and spread, including fuel moisture, mineral

content, and fuel depth. Field observations suggest that the presence of pine cones on and within the forest floor might facilitate ignition of intermixed forest floor fuels. We investigated the effect of cone fuel additions on the ignition of underlying forest floor from fuels collected in long-unburned longleaf pine (Pinus palustris Mill.) forests in north Florida, USA. Fuels were wetted to threshold gravimetric moisture contents to evaluate the relative effect on ignition. In stark contrast to fuelbeds without cones, in which duff ignition only occurred in 17% of samples, those with cones added ignited the underlying duff 94% of the time. Flame heights were 40% taller and flaming duration 47% longer in fuelbeds with cones. Where present, pine cones act as vectors of ignition for forest floor fuels, and their role in fires deserves more attention to enhance our understanding of forest floor combustion.

Keywords: duff, fire behavior, ignition vectors

Bio: Jesse Kreye is a postdoctoral research associate in the Forest and Wildlife Research Center at Mississippi State University.

19. The effects of air entrainment on the burning rate of foliage from Mountain Pine Beetle-attacked trees

Presenter: *Lasher, Trevor, HOPA Mountain Fellow, University of Montana*
Additional Author(s):
W. Matt Jolly
Rachael C. Kropp
Elliott T. Conrad

Over 9 million acres of Wyoming, Montana, Colorado and Idaho forests have been impacted by mountain pine beetles and these insects are rapidly altering forest structure. Forest structural changes may significantly alter wildland fire behavior in attacked stands but little is known about how the needle burning rate changes as they die and fall to the surface. This study attempts to imitate conditions that are experienced as needles that are held in the canopy fall to the surface. Needles from mountain pine beetle-attacked trees were collected and their flammability was tested experimental through a series of open burning experiments. Each experiment takes place on an open (ventilated), partially-enclosed, and fully-enclosed platform. The open platform imitates fuels in a canopy and the partially and fully closed platforms imitate surface fuel conditions. Multiple burns of each configuration were performed over a range of foliar moisture contents from oven dried to over 13%. Moisture content was experimentally manipulated using an environmental chamber where temperature and humidity can be regulated. We measured mass loss rate, flame height and the heat content for each experimental burn. We show that flame height, peak mass loss rates, and subsequently peak heat release rate, are higher for ventilated (canopy) fuels than for non-ventilated (surface) fuels. This suggests that models that incorporate the impacts of mountain pine beetle on wildland fire behavior must account for the changes in burning rates that are induced by differences in air entrainment into the flame zone and it also suggests that while total net heat content of foliage is conserved, the heat release rate of canopy fuels it greater due in part to this increased entrainment.

Keywords: Mountain Pine Beetle, Moisture Content, Heat Release, Fire Behavior

Bio: I am a senior at the University of Montana and who is interested in the relationships revolving around mountain pine beetle. I have studied the relationships between mountain pine beetle and

pathogenic fungus for my first two years of undergraduate study. I now have an opportunity to volunteer at the fire lab where we are looking at the relationships between mpb and fire.

20. Effects of a First-Entry Prescribed Burn in Southwestern Mixed Conifer

Presenter: *Poling, Megan, M.S. Student, Northern Arizona University*

Decades of fire exclusion, logging, and grazing have substantially altered forest structure and composition in frequent-fire systems, such as mixed conifer (Laughlin et al. 2011; Stephens & Moghaddas 2005). The ability for silvicultural treatments i.e., prescribed fire, to restore forest structure and composition as well as reduce fire hazard is of interest to land managers.
Many studies show that prescribed fire is effective at reducing the risk of extreme fire behavior by increasing canopy base height, decreasing surface fuel loads, and decreasing canopy bulk density (Agee & Skinner 2005). However, the effectiveness of this method is largely unknown in Southwest cool/moist mixed conifer types. It is our aim to determine how prescribed burning can reduce the risk for extreme fire behavior i.e., crown fires, in mixed conifer in the Kaibab National Forest, in northern Arizona. By comparing 15 plots that will be treated with fire to 15 control plots and using fire models, we seek to answer the following questions: (1) How does forest structure, composition, and surface fuel loads differ between burned and unburned sites? and (2) how effective is the treatment in reducing crowning and torching indices? We will present the pre-fire data as well as the modeled potential for crown fire for the project area. At the conclusion of our study, we will have increased our understanding regarding fire reintegration in this specific ecosystem to better guide management practices in the future.

Keywords: treatment, mixed conifer, southwest, Arizona, prescribed fire

Bio: Megan Poling is a Forestry Masters of Science student at Northern Arizona University. After she obtains her degree, she is pursuing a career as a fuels specialist with the U.S. Forest Service.

21. Modeling Large Fire Growth Potential in the Alaskan Taiga

Presenter: *St. Clair, Tom*

Recognizing that managing for natural resource is a prime objective for much of Alaska's land area, making decisions to limit suppression efforts while still protecting a wide variety of values at risk requires an assessment of each fire's growth potential. FSPro analysis has become a staple for decision-makers when making resource allocations, identifying values at risk, and prioritizing actions on individual incidents. Using the large database of free burning fires, a long history of Canadian Forest Fire Danger Rating System (CFFDRS) Fire Weather Indices (FWI), and 13 years of Moderate Resolution Imaging Spectroradiometer (MODIS) fire detection data, specific fire growth events are linked to local weather condition. The results may influence FSPro inputs and help align the model with the "boom and bust" fire growth pattern observed.

Bio: Tom started his fire career on a BLM engine crews in southeast Idaho. He then moved to Alaska and worked as an Alaska Smokejumper. After putting fires out for many years he switched gears and joined the Military Zone's active fuels management and prescribed fire program. Now he is the Fire Management Officer for Alaska Fire Service's Galena Zone which manages fire for most of Northwest

Alaska. Tom has a B.S. in Forest Resource Management from The University of Idaho and a M.S. in Natural Resource Management from the University of Alaska Fairbanks. Tom used to spend winters skiing and mountaineering around the world but now that he seems to be working most of the winter he spends his evenings and weekends working with his bird dogs and cutting wood for the cold Alaska winters.

22. Fire Regime Syntheses in the Fire Effects Information System (FEIS)

Presenter: *Abrahamson, Ilana, Ecologist/Science writer, FireCenter, University of Montana/ Fire Effects Information System, Missoula Fire Sciences Laboratory*
Additional Author(s):
Zouhar, Kris, Ecologist/Technical information specialist, Missoula Fire Sciences Laboratory, Rocky Mountain Research Station

Scientifically sound, up-to-date information on historical fire regimes can inform managers and planners about the ecological role of fire in particular ecosystems. To address managers' needs for syntheses of the growing body of research on historical fire regimes, we developed a new product, the Fire Regime Synthesis, in the Fire Effects Information System (FEIS, http://www.feis-crs.org/beta/). Fire Regime Syntheses present current information on historical fire frequency, spatial pattern, extent, and seasonality; historical ignition sources; and typical patterns of fire intensity and severity. They also provide information on contemporary changes in fuels, especially in relation to their potential to influence fire regimes. Fire Regime Syntheses bring together information from 2 sources: the scientific literature and the Biophysical Settings (BpS) models and associated geospatial data developed by LANDFIRE (http://www.landfire.gov/fireregime.php). Each Fire Regime Synthesis links to related species reviews in FEIS. In the future, the species reviews will be linked to relevant Fire Regime Syntheses, so up-date-date fire regime information will be available for all 1,100 species reviews in FEIS.

Keywords: fire regime, fire effects, fire ecology, FEIS
Bio: Ilana is a science writer/ecologist with the FireCenter at University of Montana, and the Fire Effects Information System (FEIS) at the Missoula Fire Sciences Laboratory. Ilana received her MS in forestry from the University of Montana and worked for the National Park Service for over 10 years.

23. Effects of Fire Severity on Herbaceous Vegetation Recovery, following a Southwest Ponderosa Pine Wildfire.

Presenter: *Amato, Victoria, Natural Resource Planner/ Project Manager, SWCA Environmental Consultants*
Additional Author(s):
Lightfoot, Dave, PhD. Senior Ecologist, SWCA Environmental Consultants
Stropki, Cody, PhD. Watershed Scientist, SWCA Environmental Consultants

This poster presents research on the effectiveness of aerial seeding conducted on private lands by the Natural Resources Conservation Service (NRCS) following the Trigo Wildfire of April 2008, which burned 13,709 acres of ponderosa pine and mixed conifer in the Manzano Mountains of central New Mexico. The general objectives of this research were to (1) determine the effects of fire severity on the recovery of forest understory vegetative communities and determine how different plant species respond to fire severity; (2) determine the response of intentionally seeded grass species used in restoration efforts by

the NRCS (annual rye grass, Lolium perenne and tall wheat grass, Thinopyrum ponticum) to high and low fire severity; (3) evaluate the relative recovery responses of native and exotic plant species to fire severity. Three years of post fire monitoring revealed that both native and non-native seeded species were dominant throughout the 3 years of measurement, with timing of species dominance related to time since fire. Immediately post fire, areas were colonized with native forbs, shrubs and grasses; as time progressed natives became less dominant and seeded species dominated cover. Annual rye grass was first measured in the fall of 2008 on plots burned at high severity; none was present on the low severity plots during the same measurement period. The spring 2009 measurements showed the occurrence of both seeded grasses on the high and low sites with the annual rye grass being the dominant species measured on the low severity plots. The presence of tall wheat grass began to become evident on the high severity sites at this time, however, it wasn't until the fall of 2009 that this species was seen growing at the low severity plots. By the end of the second monitoring year the annual rye grass had been replaced on all plots by the tall wheat grass and other native forbs, grasses, and shrubs. Bare ground dominated the high severity watersheds initially following fire, however it decreased rapidly as forbs and grasses became established in subsequent years. The ground cover on the low severity plots was dominated by litter throughout the course of the monitoring, with slight increases in grass and forb cover over time. The study concludes that aerial seeding efforts were successful on all high-severity plots with dominance of seeded annual grasses, however native forbs were very important in providing ground cover during the second and third post-fire years.

Keywords: ponderosa pine, aerial seeding, fire severity, native plants, non-native plants

Bio: Ms. Amato is a Natural Resource Planner and Project Manager at SWCA Environmental Consultants, specializing in fire ecology, forest management and community fire prevention planning. She has designed and implemented a number of fire monitoring projects in New Mexico and Colorado and specializes in the monitoring of burn severity. She holds a Masters Degree in Forestry and Fire Ecology from Colorado State University where she studied burn severity classification and the effects of fire on wildlife and habitat.

24. Mathematical Simulation of the Impact of Forest Fire on Typical Soils in Russia

Presenter: *Baranovskiy, PhD, Nikolay, Assistant Professor, National Research Tomsk Politechnic University*
Additional Author(s):
Olaleye A.O., Associate Professor, National University of Lesotho

There is sparse data on the effect of Forest fires in the Russia and this represents a major driver of change at the ecosystem and landscape levels. To evaluate the ecological vulnerability of fire, two factors that are normally used are environmental and vegetation features. Forest fires often resulted in ecological, economic and social damage to many states of the world. Forest fires influence on microbiocenoses in soil, physic-chemical; properties as well as on water exchange within the soil. The aim of this present investigation was therefore to predict and estimate influence of forest fires on typical soil properties from the Tomsk region of Russia.. The main purpose of the paper is the development of mathematical model for estimating the influence of thermal modes of forest fires on soils, especially in surface layers (0-20cm thickness). Some variants of influence of seats of forest fire on soils - a fiery storm, a crown fire, transition of a surface fire in a crown fire, surface fire and the coke rest burning are considered. For each of influence variants the temperature in a zone of forest fuel burning is

characteristic. Physical model of heat transfer in layered structure of soil is developed on the basis of natural observations over seats of forest fires. The geometry of area of the decision is presented by four separate zones - clay, organic matter, forest fuel and air. The area of raised temperature is set and material pyrolysis is considered in forest fuel layer. The physical and chemical processes proceeding in a layer of air, in the given work it is neglected. The mathematical model is presented by system of the non-stationary equations of heat conductivity with corresponding initial and boundary conditions. For the decision of the equations finite-difference numerical method is used. Temperature distributions in soil layer for various types of forest fires are obtained as a result of the problem decision. Dependences of temperature on various depth of soil from time of influence process are obtained also. Obtained results open a new scientific direction in the field of forest fire ecology - physical and mathematical theories of an estimation of forest fire ecological consequences for soil covers.

Keywords: Forest Fire, Mathematical Simulation, Microbiocenoses, Russia, Top soil

Bio: Presenter Bio: Baranovskiy Nikolay Viktorovich was born on April, 13th, 1978 in Tomsk (Russia). In 2000 he is graduated from the University and has entered in postgraduate study. Since 2005 worked as younger Research Assistant at Scientific Research Institute of Applied Mathematics and Mechanics, Russia. In 2007 has presented the Ph.D. Dissertation on a theme «Mathematical modelling of the most Probable Scenarios and Conditions of Forest Fires Occurrence». Since 2008, he has been training in doctoral studies of The National Research Tomsk Polytechnic University, Russia. Since 2011 till now he is working with the Power Institute of National Research Tomsk Polytechnic University as an Assistant professor.

25. Daily Fire Weather And Environmental Factors Influencing Burn Severity Of 42 Forest Fires In Central Idaho And Western Montana, 2005-2007 And 2011

Presenter: *Birch, Donovan, Reasearch Assistant, University of Idaho*
Additional Author(s):
Morgan, Penelope, Professor, University of Idaho
Kolden, Crystal, Assisstant Professor, University of Idaho
Abatzoglou, John, Assisstant Professor, University of Idaho
Dillon, Gregory, Spatial Fire Analyst, Missoula Fire Sciences Lab
Hudak, Andrew, Research Forester, Rocky Mountain Research Statio
Smith, Alistair, Assisstant Professor, University of Idaho

Burn severity as inferred from satellite-derived differenced Normalized Burn Ratio (dNBR) has been used in many large-scale studies evaluating fire impacts on ecosystems but the environmental controls on burn severity across large forest fires are poorly understood. We used infrared perimeter maps on forty-two large forest fires in central Idaho and western Montana to locate areas that burned in a known 24-hour period. We then used Random Forest to analyze dNBR within those daily areas burned relative to five daily weather observations, seven 34-yr climate percentiles, five topographical measurements, and three vegetation characteristics at 10,819 randomly located points within the daily areas burned. We were able to sample 353 fire days with daily areas burned totaling 111,200 ha. We found that percent existing vegetation cover had the largest influence on changes in burn severity. Although this could be due to scale, given many topography and vegetation variables (30 m) accounted for more of the variability than many climate and weather (4 km) variables, we posit that this reflects the influence of

local "bottom-up" fuel and topography variables on burn severity and that vegetation conditions due to prior disturbance and management affect vegetation response even when fires burn severely.

Keywords: area burned, burn severity, dNBR, infrared perimeter mapping, Random Forest, wildland fire

Bio: The presenter just finished a Master of Science at the University of Idaho. He as over 12 years of wildland firefighting experience, with the majority of that time spent on hotshot crews.

26. Understanding Post-Wildfire Vegetation Trajectories in Pine-Oak Woodlands

Presenter: *Booth, Emily, Ph.D. Candidate, University of Texas at Austin*
Additional Author(s):
Fowler, Norma, Professor, University of Texas at Austin

The Lost Pines of central Texas are the westernmost stands of loblolly pine (Pinus taeda) in the United States, a portion of which is found in Bastrop State Park (BSP). They support a diverse native plant community and are the habitat of the endangered Houston toad. In September 2011, wildfires burned much of the Lost Pines and BSP during a record drought, which together killed most of the trees and much of the understory vegetation. A primary goal of BSP managers is to return BSP to the pine-oak savanna believed to have been present pre-logging, about a century ago. However, other vegetation trajectories leading to oak woodland, pine woodland, or other unknown plant communities are possible. In collaboration with Texas Parks and Wildlife staff, we are investigating how post-wildfire vegetation trajectories are affected by pre-wildfire species composition, short-term vegetation dynamics, wildfire severity and spatial patterns. Permanent plots established using FIREMON protocols have been surveyed for 12 years pre-wildfire and two years post-wildfire, allowing a longitudinal study of vegetation trajectories.

In much of BSP, pre-wildfire dense growth of yaupon (Ilex vomitoria) and dried pine needle drape caused severe burns, especially in areas that burned in the daytime. From the wildfire through summer 2012, yaupon cover decreased, and pine regeneration was greatest in plots that were scorched to moderately burned. The absence of pine seedlings in severely burned plots may have been due to seed shortage, unsuitable seedbeds, or both. In 2013, yaupon cover increased. Pine seedlings began to colonize severely burned plots, possibly due to wind dispersal of seeds and post-wildfire substrate accumulation, creating more suitable seed beds. Oaks (primarily Quercus marilandica and Q. margaretta) re-sprouted in both 2012 and 2013 in plots of every fire severity class, and increased in number and height more rapidly than pine seedlings. Early successional herbaceous species that were absent in BSP pre-fire, including Canadian horseweed (Conyza canadensis) and American pokeweed (Phytolacca americana), are now the most common herbaceous species across all fire severity classes. A preliminary survey along roads and power lines in BSP showed that invasive species remain uncommon, although some highly invasive species absent in BSP pre-wildfire are now present, most notably Chinaberry (Melia azedarach) and King Ranch bluestem (Bothriochloa ischaemum).

Keywords: fire effects, invasive species, loblolly pine, Lost Pines, pine-oak savanna, succession, vegetation trajectories

Bio: Emily Booth is a Ph.D. candidate in the Department of Integrative Biology at the University of Texas at Austin. She received her M.S. in Plant Biology and Conservation from Northwestern University and

the Chicago Botanic Garden, where she studied potential effects of climate change on Penstemon palmeri on the Colorado Plateau. Her Ph.D. dissertation research is an investigation of the effects of wildfire and restoration treatments in the Lost Pines region of central Texas. She is currently a co-leader of Central Texas SAFE.

27. How Much is Enough? 20 years of Programmatic Vegetation Monitoring on the Fishlake National Forest

Presenter: *Chappel, Linda, Fire Ecologist, Fishlake and Dixie National Forests*
Additional Author(s):
Gray, Laura, Fire Ecologist, Fishlake & Dixie National Forests
Norman, Cory, Fuels Specialist, Beaver Ranger District, Fishlake National Forest
Ivie, Russ, Fuels Specialist, Fishlake & Manti-LaSal National Forests
Campbell, Bob, retired Ecologist, Fishlake National Forest
Sorenson, Gayle, Fire Management Officer, Fishlake & Manti-LaSal National Forests

A Properly Functioning Condition Vegetation Assessment was conducted on the Fishlake National Forest in 2000 to assess vegetation conditions. We compare the estimated acreage to treat to create vegetation in properly functioning condition with the actual acreage treated since 1985. Trends for geographic areas are displayed as information to support decisions on when, project scale and how to treat vegetation across the Forest. This information factors into go/no-go decisions in managing wildfires appropriately.

Keywords: Landscape scale treatments, programmatic monitoring

Bio: Linda Chappell is the Fire Ecologist for the Fishlake and Dixie National Forests. She has worked in the area since 1985, completing studies on vegetation condition, enabling the fire management plan and helping to treat fuels and ecosystem vegetation appropriately.

28. Relationship between leaf water status and flammability of lodgepole pine foliage

Presenter: *Conrad, Elliott, USFS, RMRS, Fire, Fuel and Smoke Science Program*
Additional Author(s):
W. Matt Jolly
Rachael C. Kropp

Ecosystem process models calculate daily plant water stress based off meteorological data. Such models can be used to predict large-scale fire activity if the relationship between a plant's water status and flammability is known. The relationship between leaf water potential and ignition time, leaf water potential and relative water content, and leaf water potential and foliar moisture content was determined in lodgepole pine (Pinus contorta var. latifolia). Water potential was measured using a pressure chamber as individual fascicles air-dried in the laboratory. Fascicles were then either burned to obtain ignition times, or their relative water content was measured. Leaf water potential is strongly correlated with ignition time. As water potential decreases, time to ignition decreases logarithmically (R2 = .85). Relative water content and foliar moisture content also decrease logarithmically with water potential (R2 = .73 and .89, respectively). These results suggest that the seasonal variation in

flammability might be predicted from the seasonal variation in plant water stress, allowing the determination of threshold water stress conditions that precede an increase in fire activity.

Keywords: Leaf water potential, foliar moisture content, relative water content, flammability, lodgepole pine

Bio: Undergraduate field ecology student at University of Montana in the Department of Biological Sciences

29. Landscape-scale patterns of fire and drought in eight High Plains states, USA

Presenter: *Ford, PhD, Paulette, Research Ecologist, USDA Forest Service, Rocky Mountain Research Station*
Additional Author(s):
Jackson, Charles, Department of Geography, New Mexico State University, Las Cruces, NM
Reeves, Matt, Missoula Fire Sciences Laboratory, USFS Rocky Mountain Research Station, Missoula
Bird, Benjamim, Statistics Unit, USDA Forest Service Rocky Mountain Research Station, Fort Collins, CO
Turner, David, 5Cove NDR. LLC, UT

We examine 33 years (1980-2012) of temperature, precipitation and natural Federal wildfire occurrence data to determine landscape-scale patterns of drought and fire on the southern and central High Plains of the western United States under a changing climate. These High Plains states are in the midst of ongoing extreme drought, experiencing below normal precipitation and above normal temperatures for the past several years. Drought is expected to persist or intensify. In addition, climate change is predicted to have multiple effects on fire regimes. Our goal is to relate the frequency and size of wildfires to a precipitation, temperature and latitudinal gradient to increase understanding of fire and drought interactions on the Great Plains in the face of climate change. Annual and seasonal climate trends were quantified between 1980 and 2012 for the High Plains EPA Ecoregion using the temporal Parameter-elevation Regressions on Independent Slopes Model (PRISM) climate model datasets. Linear trends were fitted to each pixel to develop the slope, or rate of change through time for annual average precipitation, minimum, maximum, and average temperature. Changes in fire frequency and size were tested with Poisson and normal GEE models respectively including autoregressive errors and offsets for exposed land by state.

Preliminary results indicate average annual precipitation decreased across the High Plains study area by 2.8 mm yr-1(+/- 1.3 mm), and was especially pronounced during the period of June, July and August. Annual average maximum temperature increased by 0.03° C yr-1(+/- 0.015 °C), while minimum and average temperatures remained relatively unchanged. Approximately 61,000 natural wildfires on Federal and Tribal lands occurred in the 8 states from 1980 to 2012 (roughly 10% were High Plains wildfires). Overall there was a significant increase in number of fires from 1980 until circa 2005. After 2005 there was a slight decrease or leveling off in the number of fires. Total acres burned increased until 1991-92, and then acres burned plateaued until 2007, when it began to increase again. On average there does appear to be a significant increase in total acres burned over the entire 33 years. Results point to trends in reduced precipitation and increased temperatures, with more and larger fires in the region over the last three decades. Our results will be used to improve predictive forecasts of fire in the

Great Plains, which are currently prone to uncertainties related to climate projections and a paucity of information on grassland fire-climate relationships.

Bio: Paulette L. Ford is a Research Ecologist with the USDA Forest Service, Rocky Mountain Research Station in Albuquerque, New Mexico. She received her M.S. in Biology from the University of New Mexico, and her Ph.D. in Renewable Natural Resources Studies and Ecology and Evolutionary Biology from the University of Arizona. Her interests include the role of disturbance (fire and drought) in structuring grassland, shrubland and desert communities. Paulette's long-term (18-year) research uses an experimental framework to analyze the effects of season and frequency of fire on shortgrass steppe under a changing climate.

30. Characterizing Spatial Tree Regeneration Patterns Following Large Wildfires In Ponderosa Pine – Dominated Forests

Presenter: *Fornwalt, Paula, Research Ecologist, USDA Forest Service, Rocky Mountain Research Station*
Additional Author(s):
Chambers, Marin, Research Assistant, USDA Forest Service, Rocky Mountain Research Station
Battaglia, Michael, Research Forester, USDA Forest Service, Rocky Mountain Research Station
Iniguez, José, Research Ecologist, USDA Forest Service, Rocky Mountain Research Station
Sieg, Carolyn, Research Ecologist, USDA Forest Service, Rocky Mountain Research Station

Fire suppression and other factors have recently combined to produce increases in the occurrence of large wildfires in many North American ponderosa pine – dominated forests. Because ponderosa pine and other conifers in these forests generally rely on seeds from surviving trees to regenerate, there is concern about the potential for large, high severity burn patches to be converted into grasslands, shrublands, or other non-conifer forest types (e.g., aspen). However, while many tend to focus on the 'catastrophic' portions of recent large fires, significant portions of these fires often burn with a finer, heterogeneous mosaic of severities. These smaller patches of low, moderate, and high severity areas pose different concerns relative to conifer regeneration – here, ample regeneration could increase fuel loads and thus may be viewed as undesirable if it reduces the longevity of the wildfire "treatment" at mitigating undesirable fire behavior. We are currently investigating spatial patterns of tree regeneration in multiple large wildfires where pre-fire forests were dominated by ponderosa pine. The fires are distributed across Arizona, New Mexico, Colorado, and South Dakota. Each fire contains nine 4-ha plots in which the location, species, and height of all surviving and post-fire regenerating trees are recorded. Three plots per fire are located in each of three burn severity environments: low to moderate severity areas, high severity areas adjacent to surviving trees, and high severity areas more than 200 m from surviving trees. Preliminary analyses of data collected within the 2002 Hayman Fire, Colorado, indicate that low/moderate severity plots contained more than 2000 regenerating ponderosa pine and 272 other regenerating conifer trees ha-1. Plots located in high severity areas adjacent to surviving trees contained 58 regenerating ponderosa pine and 18 other regenerating conifer trees ha-1, more than 80% of which were located within 100 m of surviving trees. Plots in areas 200 m or more from surviving trees contained only 8 regenerating conifers ha-1, 6 of which were ponderosa pine; this regeneration appeared to exhibit a randomly-spaced pattern. Aspen regeneration was highly variable and showed little relation to the plot's burn severity environment, ranging from 0 to over 400 trees ha-1. Aspen regeneration typically exhibited a clumped pattern where it was found. These preliminary results suggest that concerns about conversion of severely burned areas to grasslands, shrublands, or non-

conifer forests, as well as concerns about fuel development in lightly and moderately burned areas, may be warranted in Colorado's Hayman Fire.

Bio: Paula Fornwalt got her BS in Environmental Science from the University of Delaware in 1996, her MS in Forestry from Colorado State University in 1999, and her PhD in Ecology from Colorado State University in 2009. She currently works as a Research Ecologist for US Forest Service's Rocky Mountain Research Station in Fort Collins, Colorado. Her research examines how natural and human disturbances impact plant populations and communities in Rocky Mountain forests. She is currently working on projects that explore the consequences of ongoing insect and disease epidemics, wildfire, and forest management practices on forest understories and overstories.

31. A comparison of wildfire effects on two ponderosa pine sites between 7,500 and 9,000-foot elevation on the Dixie National Forest in southern Utah

Presenter: *Gray, Laura, Fire Ecologist, Dixie and Fishlake National Forests*
Additional Author(s):
Chappell, Linda, Fire Ecologist, Dixie and Fishlake National Forests
Greenhalgh, Kevin, FMO, Dixie National Forest

Fire effects monitoring data was collected on the 2007 Kings Creek wildfire and 2009 Bridge wildfire on the Powell Ranger District of the Dixie National Forest. A comparison of pre-burn and post-burn data shows a decrease in fuel loading and changes in snag density and percent crown scorch of ponderosa pines. This comparison will be used to summarize fire effects on ecosystems and to validate the projects.

Keywords: fire effects monitoring, ponderosa pine, wildfire

Bio: I have worked on the Dixie and Fishlake National Forests since 2008 leading the fire effects monitoring crew. Throughout the summer I work with Student Conservation Association crews to collect, analyze and interpret data on prescribed burns and wildfires.

32. Evidence of high-severity fire in a 1915-25 inventory of ~200,000 forested hectares in eastern Oregon

Presenter: *Hagmann, Keala, Graduate student, Ph.C., University of Washington*

Spatially explicit, landscape-level timber inventories conducted early in the 20th century by the Bureau of Indian Affairs across hundreds of thousands of forested hectares provide detailed records of coniferous forests on the slopes and foothills east of the Cascade Range in Oregon. More than 20% of the area in ~200,000 ha of mixed-conifer and ponderosa pine forests was sampled in a systematic strip cruise tied to documented survey points. Cruisers recorded live conifers at least 15 cm dbh by species and diameter on 1.6 ha sample units. Inventoried area overlaps a 1918 fire of ~80,000 ha in ponderosa pine-lodgepole pine forests and includes high-severity burn patches in hemlock-fir forests with huckleberry understory. Patches 100-400 ha in size of few to no live trees and abundant reproduction in documented burn areas were recorded in association with the 1918 fire and at the upper elevation boundary of the moist mixed-conifer habitat where it interleaves with wetter, colder forest types. Transects in this area differ from the rest of the mixed-conifer habitat in abundance and contiguity of

area occupied by few to no trees (< 25 tph), less ponderosa pine, and fewer large trees. Large, treeless openings (≥1.6 ha), which might result from high-severity disturbance, were uncommon at the time of the inventory on these sites except for patches within the perimeter of a large fire and in the transition to wetter, colder forest types. The ubiquitous presence and abundance of large trees and ponderosa pine in all size classes supports an inference of predominantly low-severity fires in a mixed-severity fire regime with infrequent or limited high-severity fire effects. The absence of stands composed solely of small-diameter trees provides further evidence that high-severity wildfires with an extensive stand-replacement component were either absent or uncommon; such stands would presumably have existed if large gaps or openings had been created.

Keywords: historical dry forest conditions, reference conditions, mixed-conifer and ponderosa pine forests

Bio: Keala Hagmann is a graduate student at the University of Washington. She has worked closely and extensively with Professors Jerry Franklin and Norm Johnson (Oregon State University) to resurrect a spatially extensive and explicit 1915-25 timber inventory cruise of ~200,000 hectares of dry, fire-frequent forests. Keala has worked with and been supported by The Klamath Tribes, The Nature Conservancy, USFS Pacific Northwest Research Station, and The Confederated Tribes of Warm Springs to develop and explore the relevance of this data set to contemporary management of forested socio-ecosystems.

33. Mapping Landscape Fire Frequency for Fire Regime Condition Class

Presenter: *Hamilton, Dale, Professor of Computer Science, Northwest Nazarene University*
Additional Author(s):
Hann, Wendel J., PhD, Landscape Fire Ecologist, University of Idaho and US Forest Service WFMRD&A

The Fire Regime Condition Class (FRCC) concept has been in existence since the late 1990s as an indicator of landscape ecological condition of the natural fire regime. FRCC is a departure index that compares the current amounts of the different vegetation succession classes, fire frequency, and fire severity to historic condition. FRCC assessments have been widely used for evaluating ecosystem status in many areas of the U.S. in reports such as land use plans, fire management plans, project plans, burn plans, and agency reporting. FRCC requires a variety of data inputs including the amounts of different succession stages within biophysical settings, estimates of time period fire frequency and severity along with the historic reference amounts of succession stages, fire frequency and severity within the analysis area extent. The FRCC Mapping Tool (FRCCmt) has been developed by the Wildland Fire Research Development and Applications (WFRD&A) unit to spatially model FRCC within a Geographic Information System (GIS). Succession classes are available as a spatial input to the FRCCmt from LANDFIRE. The FRCC fire severity spatial input can be generated from the WFRD&A Wildland Fire Assessment Tool (WFAT) which utilizes spatial inputs from LANDFIRE along with weather inputs which are readily available. At this time, no models have been developed which enable the generation of fire frequency at a spatial scale similar to that of succession class and fire severity. This research develops and evaluates methods and data which would enable users to create such spatial fire frequency inputs to the FRCCmt. Fire frequency data being analyzed for inclusion in such a model include LANDFIRE disturbance maps, Monitoring Trends of Burn Severity maps as well as local fire history maps. Additionally, options are being analyzed for inclusion of local user knowledge into the model. Fire frequency methods and results are presented for case studies of user specified time periods including a

set of historic sub-periods based on which existing dataset best captures the fire history for a given sub-period within the post reference period. We conclude that these methods could be implemented to provide a software tool which can utilize the previously mentioned datasets to produce spatial frequency data which can be utilized as inputs for mapping of FRCC.

Keywords: Wildland Fire Frequency Fire Regime Condition Class

Bio: Dale Hamilton has been an Assistant Professor of Computer Science at Northwest Nazarene University since 2013. In addition to teaching a variety of Computer Science courses, Dale is starting an internship program and supervises the departmental computer lab.
Since coming to NNU, Dale has continued his relationship with Systems for Environmental Management working with the US Forest Service Wildland Fire Research Development and Application (WFRD&A) team, where Dale leads some of the team's software development efforts, directing the development of a suite ArcGIS based wildland fire behavior and effects and ecological departure evaluation tools.

34. Sapling Bark Allocation of Southeastern U.S. Hardwood Species in a Frequently Burned Pine-Oak-Hickory Ecosystem

Presenter: *Hammond, Darcy, Graduate Research Assistant, Mississippi State University, Department of Forestry*
Additional Author(s):
Varner, J. Morgan, PhD, Assistant Professor, Mississippi State University, Department of Forestry

Fire affects numerous aspects of plant growth and physiology, particularly those species adapted to persist in fire-prone environments. A key aspect of plant evolution to post-fire survival is bark accumulation, with many studies finding bark thickness as a strong predictor of mortality, and various species allocate bark differentially. We evaluated bark thickness of several southeastern hardwood species following prescribed fire in a longleaf pine (Pinus palustris) – oak – hickory ecosystem in the mountains of northeastern Alabama. Hardwood species sampled include four co-dominants: blackjack oak (Quercus marilandica), sand hickory (Carya pallida), common persimmon (Diospyros virginiana), and chestnut oak (Quercus montana). Using bark thickness and inside bark diameter measurements taken every 20 cm from the main stem of saplings (average age 4-5 years), we found that while average wood diameter did not differ ($P=0.96$) across species significant differences occurred in the ratio of bark to wood ($P<0.001$). Blackjack oak had a bark:wood ratio 3x that of the next highest species, sand hickory, which was 2x that of persimmon. An examination of bark thickness taper reveals that while other species allocate similarly to bark along the length of their stem, blackjack oak allocates relatively less to bark as height increases. These results have important implications for restoration and management as they seek to understand reference conditions and whether or not a species may have invaded an ecosystem due to changing disturbance regimes. These results also further illuminate the adaptive strategies of a diverse suite of hardwoods to a historically frequent fire return interval.

Keywords: fire-adaptive traits, tree mortality, bark taper, ecological restoration

Bio: Darcy Hammond is a Masters student in the Department of Forestry at Mississippi State University with research interests in forest, fire, and evolutionary ecology. She received her Bachelor of Arts in Biology from Agnes Scott College in Decatur, Georgia. Her hometown is Chicken, Alaska, and yes that is the actual town name.

35. Evaluating Landscape Wildland Fire and Fuel Management Effectiveness with Modeling and Validation: An Initial Investigation

Presenter: *Hann, PhD, Wendel, Landscape Fire Ecologist, University of Idaho and US Forest Service WFRD&A*
Additional Author(s):
Strand, Eva K., Assistant Professor, University of Idaho

Evaluation of wildland fire and fuel management effectiveness in achievement of planned objectives has become an important issue. Landscape scale modeling has become common for applications in widland fire and fuel management decision support, planning of wildland fire control strategies and fuel management treatments. We have observed that in many cases the evaluation methods for effectiveness of wildland fire and fuel management incidents or projects does not compare the actual post-management outcome to the planned objectives using the same landscape models and methods applied during planning. We assumed that objectives would be developed using business management SMART principles: specific, measurable, attainable, relevant, and time bound. Our evaluation of management effectiveness raised four important questions: 1) What are the size and multiple site complexity conditions when landscape modeling provides substantial improved insight to management implications over site modeling for either planning or evaluation of outcomes? 2) How can the landscape models used in planning be applied with post incident or treatment inputs, using imagery or field validation, for determining how well the incident and treatment outcomes achieve the planned objectives? 3) Does use of extensive imagery and field validation of landscape model results directed at derived variables, such as canopy base height or fuel models or loading, provide better insight than evaluation of their input variables, such as existing vegetation type, canopy cover, and height? We conducted our initial investigation of these questions using review of scientific literature and wildland fire and fuel management documents combined with case studies of wildland fire and fuel management incidents and projects. Our initial analyses raised many questions that could be addressed in future efforts. We conclude that use of the same landscape scale models used in planning, with imagery or field validation of the wildland fire incident or fuel treatment outcomes, provide a very useful process for evaluating effectiveness in achieving objectives.

Keywords: wildfire, wildland fuel, management objectives, monitoring, landscape modeling, treatment effectiveness, imagery and field validation

Bio: Wendel is a landscape fire ecologist, with over 40 years experience. Current work with the University of Idaho and the US Forest Service Wildland Fire Management Research, Development, and Applications (WFMRDA) unit provides technology transfer in fire and fuel management, ecology, and LANDFIRE. Wendel retired from the U.S. Forest Service in 2009 with more than 30 years experience ranging from fighting fires to later work in fire and fuel management to landscape ecology research to his last assignment as National Landscape Fire Ecologist. Wendel has a PhD from the University of Idaho, and MS and BS from Washington State University.

36. Low-Severity Fire Increases Tree Defense from Mountain Pine Beetle

Presenter: *Hood, Sharon, Ecologist, University of Montana*

Additional Author(s):
Sala, Anna, Professor, University of Montana
Heyerdahl, Emily, Research Ecologist, USDA Forest Service

Wildfire and bark beetles are the two largest disturbance agents in North American conifer forests and have interacted for millennia to drive forest composition, structure, and ecological processes. Recent widespread mortality in western coniferous forests due to bark beetle outbreaks have been attributed in part to increasing temperatures and drought associated with global climate change. In fire-dependent forests, fire exclusion has also led to uncharacteristically dense forests which are also thought to be more susceptible to bark beetle outbreaks due to increased drought stress in individual trees. These mortality events have spurred strong interest in the interaction of fire and bark beetles in driving forest dynamics under a changing climate. One understudied aspect of this interaction is the impact of fire on tree defense. Low and mixed-severity fires are often followed by spikes in bark beetle attacks that cause additional tree mortality from the fire alone. Increases in bark beetle attacks after fire are short-lived; however, and little evidence exists of fires inducing bark beetle outbreaks. We hypothesized that low-severity fire stimulates long-term tree defense from bark beetles, after an initial, transient decrease in resistance. We found fire increases resin duct production in ponderosa pine (Pinus ponderosa Dougl. ex Laws.) and that duct production is lower when fire is excluded. We also show that trees surviving mountain pine beetle (Dendroctonus ponderosae Hopkins) attack produce larger and more ducts than trees that died from beetle attack. This implies that frequent, low-severity fire primes trees to mount a rapid defense response to combat increases in bark beetle pressure. We also examined stand-level 10-year postfire patterns of bark beetle attack at the Montana Fire and Fire Surrogate study site that includes four thinning and burning treatments. Tree mortality from bark beetles was higher in control and burn-only treatments than in thin-only and thin-and-burn treatments, suggesting increased individual tree defense scales up to impact stand-level resistance. Our findings show how removing a frequent disturbance from a system (fire) may increase the severity of another disturbance (bark beetles) besides changes to forest structure alone. This unintended consequence of altered disturbance regimes may increase susceptibility to bark beetle outbreaks in forests dependent on frequent, low-severity fire.

Keywords: tree mortality; disturbance interactions; treatment effects; bark beetles

Bio: Sharon Hood is currently pursuing a PhD at the University of Montana in the Organismal Biology and Ecology Program under Anna Sala. Her dissertation research focuses on the impact of fire on tree defense from bark beetles. Sharon worked at the Fire Sciences Lab in Missoula, MT for 12 years as an ecologist. Her primary research interests include studying mechanisms of tree death, the role of disturbance in shaping forest ecosystems, and appropriate management options to meet a variety of ecological objectives. Her past work has focused on post-fire tree mortality and bark beetle interactions.

37. Fire Effects Information System: Now spatially searchable

Presenter: *Innes, Robin, Ecologist/Writer, Missoula Fire Sciences Laboratory*
Additional Author(s):
Fryer, Janet, Ecologist/Editor-Writer, Missoula Fire Sciences Laboratory

A new spatially searchable user interface for the Fire Effects Information System (FEIS) is available to better serve the needs of scientists, managers, students, and the general public seeking information

about fire effects and historical fire regimes. The new user interface can be found at http://www.feis-crs.org/beta/. Currently in the testing and refinement phases, the new interface offers many new features, including the ability to search for species reviews, fire studies, and information on fire regimes by 1) species name, 2) geographic area—including agency, 3) life form, 4) invasiveness, and 5) nativity.

Keywords: fire ecology, fire effects, historical fire regimes, plant communities, plant species, wildlife species

Bio: Robin Innes is a writer for the Fire Effects Information System (FEIS) at the Missoula Fire Sciences Laboratory. Robin graduated with an M.S. in Ecology from the University of California Davis and a B.S. in Wildlife Management from the University of New Hampshire. Prior to becoming a writer she spent nearly 10 years conducting biological investigations of wildlife and their habitats. Robin synthesizes available literature regarding historical fire regimes and species' responses to fire for FEIS.

38. Algorithmic Inventorying of Snags in Post Fire Environments Using Remote Sensing Techniques

Presenter: *Kent, Kevin, M.S. Candidate, Northern Arizona University*

In fire burn areas, large snags play an important role in the post fire ecosystem regime, including aspects such as forest nutrient cycling, morphology, fire dynamics, wildlife habitat, as well as larger issues such as carbon sequestration modeling. Currently, the only method for estimating Ponderosa Pine snag volumes after a fire is conducting measurements on the ground using small test plots and extrapolating the generated statistics across a fire, a method that is expensive, time consuming, and introduces uncertainty to estimates. This research investigates the feasibility of using the existing aerial photography record in conjunction with GIS and remote sensing techniques to inventory the volume of standing wood left after a fire in an inexpensive, efficient, and remote manner. Analysis is performed using high resolution scans of three band true color aerial imagery obtained from the Aerial Photography Field Office. While higher resolution and color-infrared imagery is available, it is expensive; scanned aerial photographs provide the best opportunity for widespread adoption of this analysis method in the future. To perform the inventory, many attributes of the snags are used, including spectral signature, pattern, shape, and texture, to resolve snags. Furthermore, analysis is done iteratively using machine learning to enhance the accuracy. To validate the model, plot data from ground surveys previously performed on the Hochderffer and Pumpkin fire burn areas in Northern Arizona is used to assess the accuracy of the GIS model. The ultimate goal of this research is to create an exportable algorithmic model for inventorying snags that can be used in the future by researchers and forest managers who are not necessarily experts in GIS and remote sensing, but have access to aerial imagery and GIS software.

Bio: Kevin is a Masters student in Applied Geospatial Sciences at Northern Arizona University. He completed his Undergraduate coursework at the University of Montana obtaining a degree in Geography/GIS. His research is funded through a Graduate Research Innovation Award (GRIN) from the Joint Fire Science Program (JFSP)

39. Ecological refuges in large wildfires: unburnt patches in the Kilmore East-Murrindindi fire area, Victoria, Australia.

Presenter: *Leonard, PhD, Steve, Research Fellow, La Trobe University*

Additional Author(s):
Bassett, Michelle, PhD candidate, Deakin University
Chia, Evelyn, PhD candidate, Deakin University
Robinson, Natasha, PhD candidate, La Trobe University
Bennett, Andrew, Professor, Deakin University
Clarke, Mike, Professor, La Trobe University

Large wildfires contribute to landscape heterogeneity in many ecosystems. Unburnt vegetation patches within fire boundaries can act as refuges for plants and animals, allowing species/populations to survive fire and persist in the post-fire landscape. The Fire Refuges Project is a collaboration between researchers from La Trobe and Deakin Universities in Victoria, Australia. We are investigating the occurrence, attributes and value for biota of refuges in the post-fire landscape of the Kilmore East-Murrindindi fire that occurred in February 2009. These fires affected approximately 250 000 ha of mainly forested landscape, as well as destroying over 1700 houses and causing 159 human fatalities. A key question for the project is how the interaction of planned burning and wildfire affects the occurrence and function of refuges.

Refuge functions change over time post-fire. A patch can fulfil the function of allowing biota to escape the passage of fire simply by remaining unburnt, with other attributes of the patch mattering little. However, patch attributes are important for longer term persistence of species in the post-fire landscape, in particular the degree to which the patch provides resources that are scarce in the burnt landscape.

We examined the factors influencing whether patches remained unburnt during the Kilmore-East Murrindindi fire. Unburnt patches >1ha in area were rare, comprising only about 1% of the fire area. Unburnt patches typically occurred in deep, rainforest or wet forest gullies. Generally, time since fire (a surrogate for fuel structure) had only a minor influence. However, in dry forest, there was a strong negative relationship between time since fire and the likelihood of patches remaining unburnt. Differences in the mechanisms producing unburnt patches are reflected in their post-fire habitat attributes, and hence their refuge value for any given species. Planned burning may increase the likelihood that dry forest patches will remain unburnt during wildfire, but also reduces habitat structural complexity and hence patch refuge value for some species.

We found that unburnt patches had greater species richness and abundance of birds and greater abundance of arboreal mammals than burnt patches. In addition, patches with longer time since fire had greater bird abundance and a distinct species assemblage, probably reflecting greater habitat structural complexity and food resources.

Our findings suggest that while unburnt patches are rare and comprise a small part of the fire area, they play an important role in maintaining biodiversity post-fire.

Keywords: large fires, fire refuges, unburnt patches, planned burning, eucalypt forest, fauna, Australia

Bio: Steve completed his PhD at the University of Tasmania, studying the effects of grazing on grassland fire potential. Since moving to La Trobe University, he has pursued his interest in the interactions of

fauna, vegetation and fire through and is currently working on fire ecology projects in eucalypt forest and Mallee systems.

40. Spruce-Fir Colonization Following a High-Severity Fire in 1685 in Southern Arizona

Presenter: *Lynch, PhD, Ann M, Research Entomologist, US Forest Service, Rocky Mountain Research Station*
Additional Author(s):
O'Connor, Christopher D., PhD., Postdoctoral Research Associate, School of Natural Resources & the Environment, University of Arizona
Falk, Donald A., Associate Professor, School of Natural Resources & the Environment, University of Arizona
Swetnam, Thomas W., Director and Professor, Laboratory of Tree-Ring Research, University of Arizona

The spruce-fir forest of the Pinaleños Mountains in southeast Arizona burned in a high-severity fire in 1685. No fires entered the spruce-fir forest between 1685 and 2004, when it again burned in a high-severity fire. We dendrochronologically reconstructed tree population dynamics over the 300+ years between the two fires from 58 plots on a gridded sample design. Engelmann spruce began recruiting in the burned area within 10 years, and dominated recruitment throughout most of the 300 year period of reconstruction. Corkbark fir began recruiting within 30 years, but did not recruit in large numbers until the late 1810s (120 years post-fire). Both species appear to have recruited from isolated refugial popopulations in cienegas and steep canyons. A 900-ha burned area was not fully colonized for 120-180 years. Fire was excluded from the adjacent mixed-conifer forest beginning in the 1870s. Spruce and fir immediately began recruiting rapidly in the mixed-conifer, and doubled in extent within 40 years. Prior to the 2004 fire, spruce occupied 2.5 times the territory it did before fire exclusion.

Keywords: regeneration, recruitment, dendrochronology, multi-century, landscape scale, fire exclusion

Bio: I am a Research Entomologist with the US Forest Service RMRS, and have an adjunct appoint at the Laboratory of Tree-Ring Research at the University of Arizona. My research focuses on high-elevation disturbance ecology and the effects of climate change on forest insects. The Pinaleño Demography Project dendrochronologically reconstructs tree population demographics, fire history, and insect outbreak history at the mountain range scale, investigating the interactions between tree populations, disturbance agents, climate, and humans. I also study the ecology of spruce aphid, an exotic in Southwestern montane and Northwestern maritime ecosystems, and on decision support models and systems for land management planning.

41. Study of vegetation regeneration in post-disturbance environment in Sierra Nevada region of California by remote sensing method

Presenter: *Meng, Ran, Department of Geography, University of Utah*
Additional Author(s):
Denison, Philip, Professor, University of Utah
D'Antonio, Carla, Professor, University of California, Saint Babara
Moritz, Max, Professor, University of California, Berkeley

In the Sierra Nevada region of California, local ecological processes are greatly influenced by two major stand replacement disturbances: wildfire and selective logging. A study of vegetation regeneration in post-disturbance environment is essential for us to better understand and evaluate the effects of disturbances on ecological processes such as carbon and nitrogen storage, soil erosion, water quality and forest dynamics. Vegetation regeneration varies across the landscape of a disturbance area. Many interacting factors, e.g., topography, general life form of vegetation, site water availability, land management history, precipitation regimes, and burn severity could possibly cause variations in post-disturbance regeneration. In this study, we explored and compared the degree of vegetation recovery following wildfire and selective logging over time by the help of remote sensing techniques. In the end, the effects of multiple explanatory factors on vegetation regeneration have been investigated and modeled.

Keywords: fire ecology, wildfire, logging, remote sensing,vegetation recovery

Bio: Ran Meng is a PhD candidate in the Department of Geography, University of Utah.

42. Variability in Growth Climate Relationships in Mixed-conifer Forests of Central Oregon and Response to Fire Exclusion with Implications for Climate Change

Presenter: *Merschel, Andrew, Faculty Research Assistant, Oregon State University*
Additional Author(s):
Spies, Thomas, Research Forester, USFS PNW Research Station
Heyerdahl, Emily, Research Forester, USFS RM Reseach Station

Maintaining a backbone of large and old shade intolerant trees as a primary and persistent structure is a key management goal in mixed-conifer forests of central Oregon. Twentieth century logging selectively removed large old-growth ponderosa pine from mixed-conifer forest while fire exclusion and grazing increased the density and predominance of shade tolerant trees. Currently in mature mixed-conifer forests, climate and topography are strongly related to composition, and age structure suggests maintenance of ponderosa pine composition is restricted to the driest environments or areas disjunct from shade tolerant seed sources. In contrast, dendroecological studies suggest mature ponderosa pine historically were persistent in dry and moist environments where upper canopy composition is transitioning to dominance by shade tolerants.

Persistence and recruitment of ponderosa pine is dependent on the resilience of mature ponderosa pine to future disturbances, droughts, and a changing climate. Tree growth chronologies are used to assess tree population responses to climate, competition, and disturbance and can be used to determine how old ponderosa pine have responded to increased density and competition. We constructed multi-century (250-500 years) growth chronologies from old-growth ponderosa pine and reconstructed fire history at seven sites in the eastern Cascades and Ochoco Mountains in central Oregon to examine relationships between climate and growth prior to and after fire exclusion. Sample sites represent variability in climate, substrate, and historical fire regimes characteristic of mixed-conifer forest. Specific research questions are: 1) How do growth climate relationships and response to fire exclusion vary with historical fire regime and environmental setting? 2) Based on current growth climate relationships are old-growth ponderosa pine resilient to drought and climate change? Preliminary results suggest that in relatively dry environments frequent fire reduced competition and climate sensitivity increasing resilience to drought. In contrast in wet environments growth was more variable

and sensitive to climate prior to fire exclusion, and growth declined sharply in the 20th century showing reduced sensitivity to climate. These preliminary results suggest a stronger effect of competition related to densification in historically denser and more productive mixed-conifer environments and increasing vulnerability to drought in dry environments.

Keywords: Fire exclusion, drought, ponderosa pine, climate change, resilience

Bio: Andrew Merschel is a faculty researcher at Oregon State University. His current research focuses on historical disturbance regimes and structure and composition in mixed-conifer forest in central Oregon.

43. Snag Dynamics Following Stand-Replacing Wildfires in Dry Coniferous Forests of the Pacific Northwest

Presenter: *Peterson, PhD, David, Research Forester, U.S. Forest Service, Pacific Northwest Research Station*
Additional Author(s):
Dodson, Erich, Faculty Research Assistant, College of Forestry, Oregon State University

Large wildland fires often produce pulses of fire-killed trees that can provide economic benefits to timber communities; habitat for a wide range of vertebrate and invertebrate species; downed woody debris that contributes to soil stability and nutrient retention; and forest fuels that influence subsequent fire behavior and effects. The relative contributions of fire-killed trees (snags) to each of these functions depends, in part, on temporal patterns of decay and transitions from standing dead trees to downed woody debris. Here, we present results from a regional study designed to describe temporal patterns of snag decay and fall, surface fuel accumulations, and snag usage by cavity-nesting birds following stand-replacing wildfires in dry coniferous forests of the interior Pacific Northwest. We sampled fire-killed trees and surface fuels within a chronosequence of 159 forest stands that burned in stand-replacing wildfires between 1970 and 2007. Tree species and diameter strongly influenced the length of time snags remained standing following wildfire, with small-diameter snags falling faster than large-diameter snags and ponderosa pine snags falling faster than Douglas-fir and true fir snags. Most standing snags developed broken tops within 10-15 years following fire, after which snag fall rates declined notably. Both standing snags and logs generated by fire-killed trees reached advanced stages of decay between 15 to 40 years after fire, but decay rates appear to be somewhat faster for logs. Wildlife cavities were found in about 2.5% of standing snags sampled and in 51 of 159 stands sampled. Cavities were most commonly found in snags with broken tops, in snags with diameter between 30 and 60 cm, and in stands that had burned 10-20 years prior to our survey. Surface woody fuels increased with time since fire, reaching maximum levels within 5-20 years after fire for small-diameter fuels (≤ 7.5 cm) and within 10-30 years after fire for large-diameter fuels (> 7.5 cm). Small diameter snags generally fell without being used as nesting habitat by cavity-nesting species, serving as short-term foraging habitat and as a source of downed woody debris and fuels. Larger diameter snags stand longer, on average, but still deposit surface woody debris during the first decade after fire as branches and tops break off. Although large-diameter snags are often highly valued as potential nesting habitat, our study suggests that wildlife select nesting snags of varying sizes and species.

Keywords: snag dynamics, snag decay, wildlife habitat, forest fuels

Bio: Dave Peterson is a Research Forester with the U.S. Forest Service, Pacific Northwest Research Station in Wenatchee, Washington. Dave's research focuses primarily on restoration and management of dry coniferous forests of the interior Pacific Northwest, with emphases on forest ecosystem responses to high severity wildfires, effects of post-fire management practices, and vegetation responses to fuels management treatments. He also maintains ongoing research interests in forest vegetation responses to climatic variability and change and oak savanna ecology.

44. Leaf Litter Flammability of Eastern Deciduous Forests Species

Presenter: *Senneff, Zachary*
Additional Author(s):
Varner, J. Morgan, PhD

Plant adaptations to recurrent fires include a variety of responses that enable plants to persist in fire-prone environments. One adaptation with strong support from a wide number of species and studies is the flammability of senesced leaves or litter. In forests and woodlands of the eastern USA, there is substantial disagreement over apparent fire adaptations of deciduous Quercus-Carya ecosystems. To better understand the fire-adaptive traits of these species, we evaluated the burning characteristics of litter from ten north Mississippi tree species including 5 Quercus spp., 3 Carya spp., Liquidambar styraciflua, and Prunus serotina. Burning characteristics were determined for each species by replicating burns of 15g of dry litter. We recorded maximum flame height (cm), flaming duration (s), smoldering duration (s), and mass loss (%). We compared all ten species using ANOVA to compare interspecific flammability followed by hierarchical clustering of all metrics, including fuel depth. The best fit clustering resulted in three groups: a high flammability cluster of four oaks: Quercus marilandica, Quercus muehlenbergii, Quercus pagoda, and Quercus shumardii; a cluster of two flammable hickories: Carya ovata and Cary tomentosa; and a low flammability mixed cluster of Carya pallida, Liquidambar styraciflua, Prunus serotina, and Quercus durandii. These results show that hardwoods common to North Mississippi ecosystems have highly flammable litter with burning properties that are similar to pines which vary in their ability to sustain fire. Understanding the pyric properties of these hardwood species is important in restoration and management of eastern deciduous forests. Future work should be done to better understand suites of fire adaptation traits in the eastern deciduous forests.

Keywords: flammability, oak-hickory forests, and fire adaptations

Bio: Zachary Senneff is an undergraduate student earning his Bachelors of Science in Forestry from Mississippi State University. He has an interest in fire ecology, and is currently working on a leaf litter burning study. After his undergraduate degree, he plans to further his education in the field of fire ecology.

45. Forest recovery and trajectory in dry mixed conifer forests following bark beetle outbreaks and wildfires

Presenter: *Stevens-Rumann, Camille, Instructor and Research Scientist, University of Idaho*
Additional Author(s):
Morgan, Penelope, Professor, University of Idaho

Bark beetle outbreaks and large wildfires are of increasing concern to both managers and scientists as climatic conditions become more favorable for both to occur on larger spatial scales. However, little is known about whether bark beetle outbreaks and subsequent wildfires result in compounding or additive effects on post-fire succession. This is important, both in terms of fire behavior and post-wildfire regeneration, as these large events increasingly overlap in space in quick succession of one another. As little empirical data exists and much of the research thus far has been performed in a modeling environment, we tested these interactions using empirical data collected in the Interior Northwestern US. We collected data on 180 plots across four large wildfires that burned in 2007 across Idaho and western Montana. We focused on the dry-mixed conifer forested areas of each wildfire where the overstory was predominantly ponderosa pine (Pinus ponderosa), grand fir (Abies grandis) and Douglas-fir (Pseudotsuga menziesii). Within and surrounding each fire, we compared surface fuel loading, stand structure characteristics, and tree seedling density and age in areas affected by five disturbance "treatments": high bark beetle mortality without fire both more recent (1-3 years, red phase) and older (4-10 years, gray phase) outbreaks, high tree mortality from wildfires (no bark beetle), areas that experienced both wildfire and prior bark beetle (gray phase during wildfire), and undisturbed controls. While surface fuel loads were 100-200% higher on burned sites and older bark beetle-affected sites compared to control sites, compounding effects of bark beetle activity and wildfires were not observed in surface fuels and stand density. Tree seedling density was highest on gray bark beetle-affected stands and lowest on burned sites, but there were no additive affects observed on areas that experienced both disturbances. However, on sites with repeated disturbances both grand fir and Douglas-fir seedlings were significantly older than sites that only experienced a wildfire. Overall the effects of wildfire dominated stand changes and compounding effects of bark beetle outbreaks before wildfires were minimal. While results may vary by severity our study demonstrates that these disturbances are non-additive and worry about compounding effects on forest recovery or forest trajectory in high severity areas may be unwarranted.

Keywords: bark beetle and fire interactions, post-disturbance recovery

Bio: Camille works for the University of Idaho as an Instructor and Research Scientist. She completed her Masters from Northern Arizona University in 2011 and is currently working on her PhD. She has worked in multiple positions in the Forest Service in both fire and fuels before beginning her graduate work.

46. Sensitivity to Scale and Fire Regime Inputs in Deriving Fire Regime Condition Class

Presenter: *Strand, PhD, Eva, Assistant Professor, University of Idaho*
Additional Author(s):
Hann, Wendel, Research Scientist, University of Idaho
Tedrow, Linda, IT Analyst and PhD Student, University of Idaho

The Fire Regime Condition Class (FRCC) concept has been in existence since the late 1990s as an indicator of landscape level ecological condition and intactness of the natural fire regime. FRCC is a departure index that compares the current amounts of the different vegetation successional classes to historic conditions as well as departure in fire frequency and fire severity. FRCC assessments have been widely used for evaluating ecosystem status in many areas of the U.S. in reports such as land use plans, fire management plans, project plans, burn plans, and reporting requirements for FACTS or NFPORS. Input data to FRCC computation includes the amounts of different successional stages within biophysical settings, estimates of current fire frequency and severity, historic reference conditions for successional

stages, frequency, and severity, and the analysis area extent. It is recommended that the analysis area is at least five times larger than the largest disturbance expected within each biophysical setting. Mapping methods and quality have substantially improved with the development of a Guidebook and the FRCC Mapping Tool with associated User Guide and Tutorial. However, our experience with use of the mapping tool indicates that the resulting FRCC metrics are particularly sensitive to the extent of the analysis area, the assumptions of current and historic fire regimes, and the resolution of the input maps. This research illustrates the influence of analysis scale and mapping resolution of fire regime inputs on the resulting multi-scale FRCC metrics in a mountain big sagebrush steppe ecosystem that is being encroached by juniper woodlands. We conclude that failure to enter input variables at appropriate scale and resolution can result in skewed FRCC departure values across the analysis area. Examples of effect on management implications are discussed. Guidance for developing appropriate scale and resolution of input data to FRCC analyses are provided.

Keywords: FRCC, fire regime, ecological departure, landscape, spatial scale

Bio: Eva Strand is an assistant professor in the Forest, Rangeland, and Fire Sciences Department at the University of Idaho. Her research focuses on quantifying landscape change across spatial and temporal scales, including global change, succession, disturbance events, invasive species, and change induced by humans. To study landscapes she uses GIS, remote sensing, image interpretation, GPS, and modeling. Strand is particularly interested in the interaction between landscape mosaics and ecological processes. Strand teaches courses in landscape and habitat dynamics, rangeland ecology, GIS, fire and fuels modeling. She is engaged in fire science outreach via the Wildland Fire Management RD&A and FRAMES.

47. Comparative Modeling of Fire Activity in Mediterranean Shrublands

Presenter: *Weill, Alexandra, University of California, Davis*

Fire behavior in a region is shaped by a multitude of factors, including available fuel, weather, topography, and human activity. Most of the research in this area has focused on temperate and boreal forests, but the conclusions derived from this body of work may not be applicable to other biome types. In fire-adapted Mediterranean shrublands, the primary determinants of fire frequency and severity have been disputed, making prediction of future activity and design of management strategies difficult. I aim to address this deficiency by creating models based on updated datasets of fire activity in shrublands of Southern California and South Africa, examining vegetation, precipitation and temperature, ocean currents, and extreme weather events and comparing results for the two regions. As climate change affects the determinants of fire activity in these biodiverse, high population density regions, this approach can help to provide an accurate picture of the most important factors.

Keywords: fire ecology, modeling, chaparral, fynbos, weather

Bio: Alexandra (Allie) Weill is a second-year PhD student in the Graduate Group in Ecology at UC Davis. She is a member of the Latimer lab, which studies how environmental variation and change affect plant communities, populations, and species. Allie is most interested in the relationship between plants, climate, and fire in Mediterranean shrublands over the short and long term. She has a BA in Biological Sciences and a BS in Geophysical Sciences from the University of Chicago.

48. Multidecadal trends in burn severity and patch size, 1900-2007

Presenter: *Wells, Ashley, Research Assistant, University of Idaho*
Additional Author(s):
Morgan, Penelope Ph.D., Professor, University of Idaho
Smith, Alistair M.S., Ph.D, Professor, University of Idaho
Hudak, Andrew T., Ph.D, Research Forester, USDA Forest Service, Rocky Mountain Research Station, Moscow, Idaho
Hicke, Jeffrey A., Ph.D., Professor, University of Idaho

How the proportion of area burned severely has changed over time is critical to understanding trends in the ecological effects of fire, but most assessments over large areas are limited to 30 years of satellite data. Little is known about multidecadal trends in burn severity, patch size and patterns of high severity reburn. We analyze the change in area burned severely, proportion of area burned severely, and patch size of high severity burns across 346,266 ha in the Selway Bitterroot Wilderness Area in Idaho and Montana, USA. We used 30-meter fire perimeters and burn severity classes inferred from 1984-2007 satellite imagery from the Monitoring Trends in Burn Severity (MTBS) project and from1900-2000 Historical Aerial Photograph Severity (HAPS). Fires occurred in 38 out of the 107 years in the record; 13 of these in the Early period (1900-1934), 4 in the Middle (1935-1974), and 21 in the Late (1975-2007). Although 78% (270,842 ha) burned at least once, and 48% (131,198) of that area burned severely with >70% tree mortality, there was no trend in total area burned severely through time, nor in proportion of area burned severely through time. Median patch size decreased through time and the number of high burn severity patches increased. The spatial patterns of high severity burns leave a lasting legacy on the landscape. The median value of years for fires that burned with high severity in the Early period and reburned again with high severity, was 67 years which represents only 1% of the area reburned. Understanding how area burned severely is changing over multiple decades will help ecologists and land managers better understand where, when, and why fires burn severely and their consequences, past, present and future.

Keywords: aerial photography, burn severity, fire ecology, Monitoring Trends in Burn Severity, burn area

Bio: Ashley recently completed her M.S. in Forest, Rangeland, and Fire Sciences at the University of Idaho. Working with Penelope Morgan, and with help from the NASA Extreme Fire Project, her research on fire history in the Selway Bitterroot Wilderness Area is focused on analyzing the changes in area burned severely and the spatial patterns of high severity burns and reburns through time.

49. Fire Perimeter Delineation and Reconstruction from Geo-referenced Photographs using Google Earth Pro

Presenter: *Amato, Sam, Fire Application Specialist, USFS RMRS WFM RD&A*
Additional Author(s):
Butler, Benjamin, WFDSS GIS Specialist, Widland Fire Management Research Development and Application Program
Elenz, Lisa, Deputy Program Manager, Widland Fire Management Research Development and Application Program

With increasing threats to wildland-urban interface communities and the associated safety concerns for the public and firefighters engaging in these more complex incidents, services to support fire managers in accurately predicting the potential impacts of wildfires is becoming essential to effective management. Fire modeling is the primary support service used to assess the potential fire spread, behavior, and the associated impacts. One of the limiting factors to providing quality fire modeling results to the decision makers who need them is the availability of a series of chronological accurate fire perimeters. A solution to this problem is to use Google Earth Pro to geo-reference and terrain match photographs taken of the fire not only during reconnaissance flights but during fire operations as well. In addition to providing the fire behavior analyst with the most up-to-date fire perimeter information it also provides a view of the fuels that the fire is burning in and into and the associated fire behavior. The author will demonstrate how photographs of several fires during the 2013 season were used to locate features in Google Earth Pro, and how the tools in Google Earth Pro were used to create and save perimeters for use in fire behavior modeling systems

Keywords: Fire Modeling

Bio: Sam Amato is a Fire Application Specialist with the Wildland Fire Management Research Development and Application program. Mr. Amato has a background in wildland fire operations, fuels management and fire ecology. He has worked for the WFM RD&A program since 2009 on a variety of projects related to wildland fire management technology transfer.

50. Objectifying 'Steep, Rugged, Inaccessible Terrain' for Fire Management

Presenter: *Atkinson, Tyson, National Center For Landcape Fire Analysis*
Additional Author(s):
Seielstad, Carl, Dr.

'Steep, rugged, inaccessible terrain' is perhaps the most widely used catchphrase in wildfire reporting. Fire managers invoke it to explain difficulties in control efforts, to justify the deployment or non-deployment of resources and personnel, and to validate decisions not to take direct action on incidents they might otherwise suppress. The frequent use of this phrase to justify so many different decisions led us to consider what defined steep, rugged, inaccessible terrain and where it was located. We used the USGS 1/3 arc second (10-meter) National Elevation Dataset to calculate slope and create a vector ruggedness measure (VRM) for the western United States. Elevation data and LANDFIRE fuels data (30m) were combined with comprehensive roads layers to impute hiking time to every location in the West from the nearest road using a travel time model that implements Naismith's Rule with Langmuir's correction. Distance, slope, ground cover, and barrier features were all taken into account in the model. Steep was defined from the slope layer as >40% from the Department of Agriculture's National Trail Classification System logic. The steepest grade in current trail design parameters is 40%, in lengths up to 200 feet and not exceeding 10% of the total trail length. Ruggedness was calculated using VRM by (Sappington et al. 2007), where values range between 0 (flat) and 1(most rugged). Locations exceeding the 85-percentile VRM were defined as rugged by comparing imputed roughness with high resolution aerial photography. Inaccessible was defined by setting max distance (hiking time) in the travel time model to <2 hours. Collectively, these layers provide an objective, spatially-explicit characterization of steep, rugged, inaccessible terrain which we summarize by administrative unit to reveal unexpected patterns of occurrence. The biggest weakness of the current approach is in the definition of ruggedness, which is limited by 10-meter resolution data. However, our investigation represents a starting point that

could easily be made more sophisticated. Although to some extent, steep, rugged, and inaccessible will remain in the eye of the beholder, the controversy often surrounding the use of terrain and accessibility to justify management actions suggests a need for at least some objective data to support decisions and communicate more clearly to the public.

Keywords: Firebreak, Wildland Urban Interface, Light Detection and Ranging (LiDAR), FARSITE, FlamMap

Bio: Tyson is a Graduate Research Assistant at the FireCenter, College of Forestry and Conservation, University of Montana. He completed his undergraduate work at the University of Montana and graduated with a Bachelor's degree in Forestry in 2009. He is currently in his second year of graduate school and plans to complete his Master's work this spring. After spending four years as a guide and packer in the Bob Marshall Wilderness, Tyson began his operational fire career working on an engine in Western Montana. He has also worked as a hotshot and is currently entering his fourth year as a Missoula Smokejumper. Tyson is currently the Vice President of the UM SAFE chapter and has been an active member of the club since it was created. In his spare time he likes to spend his time outdoors with his friends and family.

51. Does an Expanding WUI Actually Increase Risk of Residential Loss?

Presenter: *Leyshon, Nicola, Graduate Research Assistant at California Polytechnic State University*
Additional Author(s):
Dicus, Christopher, Professor, California Polytechnic State University
David B. Sapsis, Senior Fire Scientist, California Department of Forestry & Fire Protection

Even with increasing proportions of governmental budgets allocated to fire suppression resources, wildfires annually destroy great numbers of homes and critical infrastructure in the wildland-urban interface (WUI). To aid policy development that reduces these losses, we are evaluating changes to risk through time in dissimilar communities that are expanding into fire-prone areas. Conventional wisdom states that escalating losses are caused, in part, by an expansion of residential development into fire-prone areas. However, various mitigation strategies such as defensible space and improved construction standards have recently been mandated for new developments in California so as to reduce the risk of these losses. Further, older high-risk communities may also be subsequently buffered from wildfire as the WUI expands and lessens their exposure to flames and embers. Thus, expanding WUI may either increase or decrease risk of residential loss dependent upon the extent of altered fire exposure and the application of mandated mitigation strategies. To help elucidate this seeming dichotomy, we are utilizing various GIS strategies to spatially analyze changes to risk of structural ignitions through time in expanding, but demographically dissimilar residential communities in California.
This poster will describe how we are quantifying changes to risk based on characteristics of community wildfire exposure and characteristics of individual structures, including roofing materials, defensible space, and housing density. Our research is simultaneously (1) quantifying the growth of the WUI over time in multiple, dissimilar communities, (2) analyzing temporal changes to risk based on altered wildfire exposure and structural characteristics, and (3) comparing risk in high-compliance vs. low-compliance communities.

Keywords: WUI, GIS, fire risk, regulations, southern California

Bio: Nicola Leyshon is a Graduate Research Assistant in the Natural Resources Management & Environmental Sciences Department at California Polytechnic State University, San Luis Obispo. Her GIS-intensive research focuses on how expanding wildland-urban interface and various fire-mitigation regulations interact to impact risk of residential loss. Nicola holds a BS (with Honors) in Environmental Economics, Ecology, and Management from the University of York in the United Kingdom.

52. The AFTEERS Project: Motivation, Objectives, and Results

Presenter: *Drury, PhD, Stacy, Senior Fire Ecologist, Sonoma Technology Inc.*
Additional Author(s):
Ashley R. Russel, PhD, Air Quality Scientist, Sonoma Technology Inc.
Jennifer L. DeWinter, Atmospheric Scientist, Sonoma Technology Inc.
Angela L. Ekstrand, MS, Air Quality Scientist, Sonoma Technology Inc.
Kimberly A. Lorentz, MS, Forest/Fire Ecologist, Sonoma Technology Inc.

The NASA-sponsored feasibility study, Automated Fuels Treatment Effectiveness Evaluation Using Remote-Sensing Information (AFTEERS), links MTBS fire severity maps, GeoMac fire perimeters, NFPORS and FACTS fuel treatment databases, RAWS weather data, MODIS and LANDFIRE vegetation data, and topographic data (slope, aspect, elevation) into a single process for remotely assessing fuels treatment effectiveness.

The motivation for the AFTEERS project was to provide tools to aid land managers tasked with mitigating the adverse effects of wildfires. Specifically, we wanted to determine whether we could use NASA Earth observations to evaluate fuels treatment effectiveness in a meaningful way. Documented evidence indicates a growing threat of wildfires, which is projected to increase as climates continue to warm. These increasingly frequent fires also tend to be larger and more severe. Land managers cannot change the weather or alter climate, but they can alter fuels by treating them mechanically or through prescribed burning.

However, there are no easy-to-use, rapid, or inexpensive methods to evaluate whether fuels treatments are effective. In fact, recent U.S. Government Accountability Office (GAO) reports have identified a need for land managers to evaluate the efficacy of fuels treatments for mitigating fire hazard. Consequently, fire managers have expressed a need for tools that better evaluate the performance of fuels treatments. To address this need, we have developed a method for rapidly and efficiently assessing wildland fuels treatment effectiveness using satellite observations and associated map products.

We will present the results of several case studies to demonstrate how easy access to these data sets will help land managers assess the performance of individual fuels treatments across landscapes, supporting future decision-making regarding the type and location of fuels treatments. We hope to incorporate the AFTEERS processes into existing fire management decision support systems, including the Joint Fire Science Program-sponsored Interagency Fuels Treatment Decision Support System (IFTDSS) and the Wildland Fire Decision Support System (WFDSS).

Keywords: Remote sensing, Fuels treatment effectiveness, decision support, planning

Bio: Dr Drury has been employed as the Senior Fire Ecologist at Sonoma Technology Inc. for the past five years. His current projects include senior science adviser and technical expert for the Interagency Fuels

Treatment Decision Support System (IFTDSS), the Smoke Emissions Modeling Intercomparison Project (SEMIP), the Real-time assessment of fire weather accuracy project, and the Automated Fuels Treatment Effectiveness Evaluation Using Remote-Sensing Information (AFTEERS)

53. Fire Management Planning – An Australian Perspective

Presenter: *Dubrowin, Damien, Fire Management Officer, NSW National Parks & Wildlife Service*

This presentation will examine the fire management planning system of the National Parks & Wildlife Service (NPWS) of New South Wales, Australia.
The NPWS prepares Reserve Fire Management Strategies (RFMS) for each reserve (or group of reserves) to define the strategies and actions to be implemented to achieve NPWS primary fire management objectives.

As for many fire agencies worldwide, fire management planning for NPWS is a complex business with legislative responsibilities that require the agency to take into consideration the need to ensure the protection of life (staff, neighbours and visitors) and property (neighbours, park and public infrastructure) as well as the protection and conservation of natural and cultural heritage values.
Most RFMS are presented in a large map format (A0 size) showing fire advantages, assets and fire management zones, and operational guidelines such as the protection of natural and cultural heritage. The fire management zoning for the reserve is based on a risk management, the primary fire management objectives and the presence of threatened species. The RFMS are the basis for preparing prescribed burning plans of operations and incident action plans.

In October 2013, a large wildland fire within the Sydney region, the Hall Road Balmoral fire, burned some 15,000 hectares across several land tenures. This presentation will also review the success of the NPWS RFMS framework and how it integrated into a wider multi-agency framework for fire management planning.

Bio: Damien Dubrowin is a Fire Management Officer with the New South Wales National Parks and Wildlife Service.

54. Fire Management Lessons Learned - Evolving Fire Management Programs

Presenter: *Ewell, Carol, Ecologist, U.S. Forest Service, AMSET*
Additional Author(s):
Kerr, David, Fire Management Specialist, retired USFS
Romero, Frankie, National Fire Use Program Manager, USFS

The innovative and evolving fire management programs on the George Washington and Jefferson and the Sequoia National Forest were documented in a Lessons Learned case study. These fire management programs, with the support of Forest leadership, are taking proactive steps to address agency direction in developing and maintaining fire resilient forests while assuring firefighter and public safety and economic efficiency. Historical fire and GIS data, case study information, and interviews with key members of the fire programs and Forest leadership were used to inform the case study. While these two Forests represent vastly different ecological systems with contrasting fire regimes, several common practices have allowed these Forests to become progressive fire management leaders, such as:

•Significant fire events occurred which caused Forest leadership to acknowledge that existing practices were not sustainable to maintain functioning ecosystems.
•Forest leadership embraced the concept to manage fire-adapted systems and that fire processes are a tool to improve overall forest health and enhance critical habitats for sensitive species.
•By managing wildfire for both protection and resource benefit objectives, firefighter/public safety and ecosystem health could be improved.
•The cost per acre of wildfire operations decreased when management actions were tailored to the threats and opportunities presented.
•Agency and Forest direction exists which allows these units to utilize a wide variety of fire management practices in meeting land management and public safety goals.

Wildfires managed for protection and resource objectives have benefits beyond ecosystem restoration, including the reduced need for large numbers of ground-based firefighters and aviation resources associated with incident-specific safety improvements. Both Forests observed that larger burned areas associated with fire managed under these evolving strategies are resulting in landscape level improvements in fuel conditions, and allows the Forests to focus their available fuels funding on key locations closer to communities and improvements. This strategic shift in fire management comes with leadership support. Key human factors and commonalities were seen in these two successful fire management programs. The study identified four keys to the future success of these programs. Each national forest has unique challenges in meeting the goals of developing and maintaining healthy, fire resilient forests, while simultaneously assuring for the safety of the public and firefighters. Both the George Washington and Jefferson and the Sequoia National Forests have demonstrated that, through the thoughtful use of existing agency authorities, these goals are within reach.

Keywords: Fire managment, lessons learned, evolving programs

Bio: Carol Ewell serves as a fire ecologist with the U.S. Forest Service's Adaptive Management Services Enterprise Team (AMSET). She has completed several fuel characterization, treatment effectiveness, and fire severity studies since starting with AMSET in 2003. Prior to that, Carol worked as a fire effects and fire monitor for the National Park Service in California. Carol uses her experience in fire management along with her academic and ecological background to do strong science knowledge exchange that is useful for land and fire management.

55. Long-term Growth and Mortality of Residual Ponderosa Pine in Masticated Stands Treated with Prescribed Fire

Presenter: Hamby, Gregory, Graduate Research Assistant, Department of Forestry, Mississippi State *University*
Additional Author(s):
Varner, J. Morgan, Assistant Professor, Department of Forestry and Forest & Wildlife Research Center, Mississippi State University, MS, USA
Knapp, Eric E., Research Ecologist, USDA Forest Service Pacific Southwest Research Station, Redding, CA, USA

Drastic changes in fire-prone ecosystems over the past century have prompted large-scale use of fuels treatments over vast areas of the western United States. One commonly accepted fuels treatment strategy is to retain large fire-resistant trees given their ecological importance and inhibiting influence

on surface shrub and tree fuels. Mechanical mastication is an increasingly common fuels treatment, enabling retention of large trees while shredding shrubs and small trees on site. However, novel fire behavior and resulting post-fire tree mortality has raised concern over prescribed fire use in masticated fuel beds. Our goal was to determine how prescribed fire in masticated stands influences mortality and growth of residual ponderosa pine (Pinus ponderosa) in northern California. At the Challenge site (burned in 2005) in the northern Sierra Nevada and the Whitmore site (burned in 2006) in the southern Cascades, we tracked tree status (alive or dead) and compared changes in dbh, crown base height, and total tree height following prescribed fires. Pines at Challenge experienced 29.5%, 34.0%, 34.0%, and 38.1% mortality 1, 2, 3, and 8 years post-fire, respectively. Whitmore mortality rates were much lower, 5.2% the first year and 6.5% the second year, with no additional mortality up to 7 years post-fire. A subset of trees included in a pre-burn raking experiment at Challenge did not differ significantly in basal area growth following fire ($P = 0.21$). Of surviving trees, weak or non-significant relationships were found between initial crown volume scorched and 7 to 8 years of post-fire basal area growth ($R2 < 0.07$ at both sites). Average live tree basal area increased from 0.059 m2/tree to 0.086 m2/tree at Challenge and 0.032 m2/tree to 0.051 m2/tree at Whitmore. Crown base heights also increased 3.80 m on average at Challenge and 2.54 m at Whitmore. Our observations of minimal additional mortality, coupled with observed increases in diameter and height to live crown, suggest increased post-treatment resilience in these fire-prone forests.

Keywords: Fire effects, fuels treatments, post-fire tree mortality, resilience

Bio: Greg Hamby attended St. Olaf College in Northfield, Minnesota for a B.A. in biology with a concentration in environmental studies. He is currently working on a M.S. in forestry at Mississippi State University researching the longevity of mechanical mastication as a fuel treatment.

56. An analysis of the severity patch distribution of subsequent fires on the North Rim of the Grand Canyon

Presenter: *Hoff, Valentijn, GIS Analyst, FireCenter, College of Forestry and Conservation, The University of Montana*
Additional Author(s):
Teske, Casey, Fire Scientist, The University of Montana
Riddering, Jim, Adjunct Assistant Research Professor, The University of Montana
Queen, LLoyd, Professor of Remote Sensing, The University of Montana
Gdula, Eric, GIS Specialist ,Grand Canyon National Park
Bunn, Windy, Fire Ecologist, Grand Canyon National Park

Fire severity is an important measure of change in an ecosystem. The change caused by one fire varies greatly over the extent of the fire, and can be characterized as an aggregate of patches of varying severities. The influence of the fire severity distribution of an initial fire on the fire severity distribution of a subsequent fire is important to understand for natural resource managers at Grand Canyon National Park, which has areas where fire frequency is relatively high. We quantified this relationship, through the use of geo-spatial data, derived from the Monitoring Trends in Burn Severity (MTBS) dataset, which had been field calibrated for increased local accuracy. We found that the initial fire severity patch distribution had little influence on the subsequent fire severity patch distribution. A Kappa value of 0.08 indicated that the distribution of second entry severity patches was close to random, when compared to the initial patch distribution. On the North Rim of the Grand Canyon,

between the years 2000 and 2011, 48.7% of the area that burned twice, burned with equal severity. The proportion that burned with a higher severity was 25.1% and 26.2% burned with a lower severity. The most important contributor to the large amount of agreement is the similarity in proportions of each severity class and only a small amount of agreement can attributed to a match in spatial allocation of the equal severity patches. We detected little change when comparing the high severity patch distribution of an initial fire with the total distribution after a subsequent fire. The mean and standard deviation of the high severity patch size did not change significantly after a second fire came through; the increase in area was due to an increase in size of existing high severity patches, as well an increase in the number of smaller new high severity patches. These finding can be useful for park staff that are making fire management decisions on fires which impact areas that have previously burned.

Keywords: Fire severity, spatial analysis, patch distribution, fire management, Grand Canyon National Park

Bio: Valentijn Hoff is a GIS Analyst at the FireCenter at the College of Forestry and Conservation, The University of Montana, in Missoula, Montana. He enjoys using spatial technologies in helping natural resource managers make more informed decisions. During fire season he can be found embedded with Fire Management Modules, helping Incident Management Teams with GIS, or installing remote networks for fire management. Valentijn has Master of Science degree in Forestry from the University of Montana.

57. TOPOFIRE: A system for monitoring insect and climate induced impacts on fire danger in complex terrain

Presenter: *Holden, Zack*
Additional Author(s):
Jolly, William, research ecologist, Missoula Fire Sciences Laboratory, Missoula, MT
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Klene, Anna, assistant professor, University of Montana Dept. of Geography
Abatzoglou, Jonathan, assistant professor, University of Idaho Dept. of Geography

We have developed an open source interactive web server called TOPOFIRE (topofire.dbs.umt.edu), designed as the next generation of the Wildland Fire Assessment System (WFAS). Topofire integrates NASA remote sensing and climate products into a decision support tool that delivers a suite of high spatial resolution real-time information essential to wildland fire management. TOPOFIRE uses data from massive networks of thousands low cost temperature ensors distributed across the Northern Rockies to In the current prototype, we developed three applications relevant to fire management: A. Downscaling fire danger and fuel moisture estimates with distributed sensor networks and MODIS snow data; B. Detection and mapping of beetle-killed trees with fused MODIS-Landsat data; and C. Landscape-scale application of physics-based fire behavior models that account for beetle-caused changes in forest structure. The TOPOFIRE system provides an open-sourced, online platform for rapidly assimilating complex spatial climate and fuels information for wildland fire management decision support.

Bio: Zack Holden is scientist for Region 1 of the U.S. Forest Service and affiliate faculty in the Geography department at the University of Montana. He received his PhD in natural resource management from

the University of Idaho in 2008. His current work focuses on modeling mountain weather and climate and their influence on ecosystem processes.

58. Training Tools for Smoke Management in the FRAMES Emissions and Smoke Portal

Presenter: *Hyde, Josh, Research and Instructional Associate, University of Idaho*
Additional Author(s):
Smith, Alistair, Associate Professor, University of Idaho
Lahm, Pete, NWCG Smoke Committee Chair, USFS
Fitch, Mark, Smoke Management Specialist, NPS
Strand, Eva, Assistant Professor, University of Idaho
Wells, Lynn, FRAMES Program Manager, University of Idaho

Smoke and air quality impacts from large fires have the potential to impact large populations. Great efforts are expended to minimize potential impacts from prescribed fires and address impacts from wildfires. To provide information to help managers address smoke and air quality, and make other sources of information easily accessible, the University of Idaho and National Wildfire Coordinating Group's Smoke Committee (NWCG SmoC), and Fire Research and Management Exchange System (FRAMES) coordinate to offer the Emissions and Smoke Portal (www.FRAMES.gov/smoke). The Emissions and Smoke Portal contains a diverse mix of tools to help address educational needs of both prescribed and wildfire personnel as well as data needs of researchers.
The Emissions and Smoke portal contains educational resources including the Smoke Management and Air Quality for Land Managers online resource, the interactive Smokepedia glossary, a library of recorded presentations from content experts explaining smoke policy and management approaches, and a categorized list of external links, documents, and data sources. Managers and researchers interested in the social sciences will benefit from the section focused on Public Perceptions and Tolerance of Smoke from Wildland Fires, which is an ongoing area of research aimed at investigating the publics' views and concerns regarding smoke generated by fire. Additionally, a search and browse section provides targeted access to data, documents, programs, projects, tools and web pages documented in the FRAMES Resource Cataloging System. Additional efforts by SmoC and the University of Idaho to provide smoke management guidance include work to deliver an updated version of the Smoke Management Guide, and the development of training to address smoke exposure and transportation safety.

Keywords: Training, Education, Smoke Management, FRAMES

Bio: Josh Hyde is an Instructional Associate and Program Coordinator for the University of Idaho department of Forest, Rangeland, and Fire Sciences, working remotely from the Pacific Wildland Fire Sciences Laboratory in Seattle WA. He has a BSc in Rangeland Ecology and MSc in Forest Resources from the University of Idaho. Josh works with the NWCG Smoke Committee developing outreach materials on smoke and air quality issues, perform training assessments, and coordinate outreach efforts. Josh also works with the Wildland Fire Research and Development Group reviewing geospatial fuels management tools, and reviewing and developing learning content for these tools.

59. A 'Leopoldian' Fire Ethic to Empower Ecological Fire Management

Presenter: *Ingalsbee, PhD, Timothy, Executive Director, Firefighters United for Safety, Ethics, and Ecology (FUSEE)*

Firefighters United for Safety, Ethics, and Ecology (FUSEE) is a national nonprofit organization promoting safe, ethical, ecological wildland fire management. FUSEE members include current, former, and retired wildland firefighters; fire managers, scientists, and educators; forest conservationists; and other interested citizens who support FUSEE's holistic fire management vision.

FUSEE's primary mission is to provide public education and policy advocacy in support of the emerging paradigm that seeks to holistically manage wildland fire for social and ecological benefits instead of simply "fighting" it across the landscape. We seek to enable fire management workers to perform their duties with the highest professional, ethical, and environmental standards. Our long-term goal is the creation of fire-compatible communities of workers and citizens able to work safely and live sustainably with wildland fire.

Inspired by Aldo Leopold's "Land Ethic," FUSEE advocates for a new "Fire Ethic" in fire management policies and practices:

"A thing is right when it contributes to the safety of firefighters and the public, ethical use of public resources, environmental protection of fire-affected landscapes, and ecological restoration of fire-dependent ecosystems. It is wrong when it tends otherwise."

This poster will display FUSEE's philosophy, mission, research, education, and advocacy projects. Elaboration of some key FUSEE concepts will be featured, including: the FUSEE triad of safety, ethics and ecology; re-identifying firefighters as fire rangers; promoting community fire preparation; creating fire-compatible communities, restoring fire-permeable landscapes, and the fire ethic for ecological fire management.

Keywords: firefighter safety, ecological fire management

Bio: Ingalsbee, Timothy, Ph.D. is the executive director of Firefighters United for Safety, Ethics, and Ecology (FUSEE), co-director of the Association for Fire Ecology, and an adjunct instructor and faculty research associate in Environmental Sociology at the University of Oregon. Timothy served as a wildland firefighter for the U.S. Forest Service and National Park Service. In 1993 Timothy received the Oregon Conservationist of the Year Award. In 2002, he served on the Western Governors' Association's stakeholder group for the Ten-Year Comprehensive Wildfire Strategy and National Fire Plan. Timothy is a senior wildland fire ecologist certified by the Association for Fire Ecology.

60. From Sensor to Incident Commander, The Silver Fire 2013

Presenter: *Lanier, Sam, CEO of FireWhat.Inc, FireWhat.Inc*
Additional Author(s):
Hansen, Cassandra, PhD Canidate, University of Nevada, Reno, GIO FireWhat.Inc
Doherty, Paul, Disaster Response Program, ESRI
Avela, Ryan, COO FireWhat.Inc

Wildfires in the Western United States are a natural and inevitable occurrence, yet changing conditions have increased the risk to human populations in the wildland urban interface. Since the 1990's, the response to these events have relied heavily on the use of traditional geographic information systems (GIS) for planning and operations. However, with evolution of more advanced information systems, GIS can now be used as a platform for sharing geographic information in new and innovative ways. Here we provide a case study as an example to raise awareness and discuss best practices going forward. The Silver Fire started on August 7, 2013 but ended up making wildland fire history. The Silver Fire was an extremely fast moving fire in a populated area of Banning, California. It destroyed 48 structures and burned over approximately 20,292 acres. At the peak of this fire there were over 2,106 fire personnel on scene. Yet, the response to this fire was dramatically altered with the integration of remote sensing, traditional GIS, and WebGIS. For instance, the delivery of wildfire location and geographic extent from an infrared sensor to an incoming incident management team was shortened from 12 hours to 40 minutes via dynamic web maps. We will describe the impact and show examples of WebGIS on the timeliness of information sharing for planning, operations, and public information and hope to provide an informative framework for future response.

Keywords: Applied Geography, Disaster Response, Web GIS, Wildfire

Bio: Sam Lanier has worked in a vast array of professional fields in the government, public, and non-profit sectors. He is co-founder and CEO of FireWhat.Inc which is the parent company of wildlandfire.com. His goal is to create a better way in which information is shared among the Fire and Emergency Services Communities. Lanier believes that by incorporating technology into the Fire and Emergency Services, a safer, better trained and more efficient work force will emerge.

61. The LANDFIRE 2010 Update: An Overview

Presenter: *Long, Donald, Fire Ecologist, USDA Forest Service Missoula Fire Lab*

The LANDFIRE program recently released a suite of newly updated products, called the LF2010 Update. This updated suite of products, produced between October 2012 and January of 2014, includes a circa 2010 snapshot of vegetation and fuel conditions as well as some newly mapped areas. New and improved methods were brought to bear in a number of processing steps including change detection, EVT legend revisions, and fuel products. This poster will graphically describe this effort as well as compare and contrast results of these new and improved methods with previous versions of LANDFIRE data. In addition, it will provide a short briefing on the current LF2012 effort.

Bio: Donald Long is a fire ecologist at the Fire Sciences Laboratory of the Rocky Mountain Research Station in Missoula, MT. He works for the Fire Modeling Institute within the Fire, Fuels, and Smoke Program. He earned a B.S. degree in forest science from the University of Montana in 1981 and completed a master of science in forest resources at the University of Idaho in 1998. Don began his work at the Fire Sciences Laboratory in 1994. In 2003, Don began working with the LANDFIRE Project. He is currently the Fire Modeling Institute Science Lead for the LANDFIRE project.

62. Strategic Operations Planning – It's not just for wilderness anymore

Presenter: *McHugh, Charles, Fire Spatial Analyst, Rocky Mountain Research, Fire Fuels and Smoke Program, Missoula Fire Science Laboratory*

Additional Author(s):
Fay, Brett, Deputy Director Fire, US Fish and Wildlife Service - Pacific Region
Hoyt, Stewart, Regional Fuels Specialist, USFS Region 1

Because the SOPL is a fairly new position on wildfires, not everyone understands the SOPL's role and responsibilities. Typically, when a SOPL arrives at an incident, they will have to explain their role and responsibilities to the local unit, IMO, and others. This poster will show how the SOPL position can provide value to incident management.

Keywords: Strategic Operation Planning

Bio: Charles (Chuck) W. McHugh has been a Fire Spatial Analyst for the Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, since June 2002. His current research involves spatial data analysis, large air tanker use and effectiveness, geospatial fire modeling, historical burn probability analysis, and wildfire/fuel treatment interaction and effectiveness. During fire season, he operates as a Long-term Fire Analyst (LTAN) in support of wildland fire management at the national, regional, and local levels often working with Type-1 and Type-2 Incident Management Teams in the development of long-term plans and fire analysis.

63. The Coalition of Prescribed Fire Councils: One voice for preserving the ecological role of fire

Presenter: *Miller, Kristen, Graduate Research Assistant, Mississippi State University*
Additional Author(s):
Lahm, Pete, Smoke Manager, USDA Forest Serves, Washington, D.C.
Miller, Kristen, Graduate Research Assistant, Mississippi State University
Melvin, Mark, Education & Conservation Technician, J.W. Jones Ecological Center, Newton, GA
Varner, J. Morgan, Assistant Professor, Department of Forestry, Mississippi State University

Twenty-first century prescribed fire managers face increasingly complex challenges that limit or potentially threaten the use of fire. Never before in history have land managers found these challenges broader in scope. Modern day prescribed fire managers must consider a complex web of policy, legal statutes, and liability, as well as public safety, health, and acceptance. Collectively these challenges are greater than any one landowner, group, agency, or state can address alone, and require a multi-stakeholder approach for solutions. To more effectively address prescribed fire-related issues, a diverse group of public and private leaders created a national platform to better meet these challenges. In 2008 the Coalition of Prescribed Fire Councils (“Coalition”) was developed to create one voice to assist fire practitioners, policymakers, regulators, and citizens with issues surrounding prescribed fire use. The Coalition’s core mission is to promote the appropriate use of prescribed fire for enhancing public safety, managing resources, and sustaining fire-prone ecosystems. In addition the Coalition encourages and facilitates the organization of prescribed fire councils across the US. Partnering with the existing 28 councils’ efforts, which represent twelve million acres of annual prescribed fire use, has created a forum to voice and address issues of national concern. The Coalition’s work facilitates communication among interested parties in the field of prescribed fire, provides a focal point for sharing ideas and information, and creates opportunities for prescribed fire collaboration. In this poster, we hope to capture the

"voices of prescribed fire" from conference-goers in an interactive approach. In addition, we will share the accomplishments and future goals of the Coalition.

Keywords: Prescribed fire; fire management; fire policy

Bio: Kristen Miller is a graduate research assistant in the Department of Forestry at Mississippi State University. She was born and raised in Northeast Florida just outside of Jacksonville. She received her undergraduate degree in Forestry from the University of Wisconsin Stevens Point. Kristen was a member of the UWSP Fire Crew for 4 years and served as the Secretary in 2011 and Crew Leader in 2012. She was the national SAFE Secretary for 2013 and is currently the national SAFE Vice President.

64. Great Basin Fire Science Delivery

Presenter: *MontBlanc, Eugenie, Coordinator, Great Basin Fire Science Delivery, University of Nevada*
Additional Author(s):
Pellant, Mike, Great Basin Ecologist, Bureau of Land Management, Boise, ID
Chambers, Jeanne, Research Ecologist, USDA Forest Service Rocky Mountain Research Station, Reno, NV
Schultz, Brad, Extention Educator, University of Nevada Cooperative Extension, Winnemucca, NV
Leger, Elizabeth, Associate Professor, University of Nevada, Reno, NV
Bunting, Stephen, Professor, University of Idaho, Moscow, ID
Howell, Cheri, Ecologist, USDA Forest Service, Wells, NV
Brunson, Mark, Professor and Department Head, Utah State University, Logan, UT

The Great Basin Fire Science Delivery project (www.gbfiresci.org) links managers and scientists to improve pre- and post-fire management decisions by providing relevant information and access to technical expertise. This project is one of 14 regional Knowledge Exchange Consortia funded by the Joint Fire Science Program (https://www.firescience.gov/JFSP_consortia.cfm). The project works to: 1) provide a forum where Great Basin land managers can identify technical needs with respect to fire, fuels, and post-fire vegetation management; 2) develop and synthesize the information and technical tools to meet these needs; 3) provide the information and technical tools through preferred venues; and 4) develop direct lines of communication between managers and scientists. The project is currently sponsoring five syntheses and related field guides that are focused on sagebrush and pinyon/juniper ecosystems that address effects of fire on vegetation and soils, site recovery potential, effects of livestock grazing on fuel loads, impacts of fire on runoff and erosion, and wind erosion and post-fire stabilization. Our webinar series continued this spring with webinars on topics such as drill comparisons for seeding success, Sagebrush Steppe Treatment Evaluation Project short-term results, and effects of imazapic over four years post-treatment. These and all project webinars can be found on our website and on our YouTube channel. This summer we will host site recovery potential field workshops in all five states of the Great Basin. The project also continues to support online training opportunities at University of Idaho. Future plans include continued support for information syntheses for the Great Basin, a field video series, an informal social network analysis of fire and fuels professionals, real-time discussion forums, increased social media activity, and continued assistance with finding the scientific information and/or connections needed to answer priority questions from our Great Basin land managers. We expect public and private land managers to benefit from this project by having a place and a person to turn to for answers to technical questions, leads to research contacts, and a forum to

communicate technical needs. We expect research scientists to benefit by gaining new ideas and partnerships for research and by providing new methods of outreach for research results.

Keywords: fire, fuels, vegetation, management, sagebrush, pinyon juniper, outreach

Bio: Eugénie MontBlanc is the Great Basin Fire Science Delivery Project Coordinator. Her professional interests include working with land managers and scientists to find answers to questions about fire ecology, fuels management, restoration, climate change, and landscape prioritization. Recent work includes coordinating the publication of new information syntheses, conducting informative webinars, and website design enhancements to increase access to information. Génie received her bachelor's degree in Biology from San Francisco State University, a master's in Biology from the University of Nevada, and a master's in Resource Economics from the University of Nevada.

65. Fire in the Afram Headwaters Forest Reserve, Ghana: Causes, Occurences and Management Interventions

Presenter: *Agyemang, Sandra Opoku*
Additional Author(s):
Müller, Michael, Prof., Dresden University of Technology, Germany
Barnes, Victor Rex, Dr., Kwame Nkrumah University of Science and Technology, Ghana

Afram Headwaters is one of the productive forest reserves in Ghana. Erratic rainfall pattern and prolongation of dry season, which is a result of climate change has increased forest fire occurrences in Afram Headwaters forest reserve. Annual occurrences of fire cause damages and alter the forest ecosystem. Due to these disturbances, the forest reserve does not meet the economic, environmental and social intended purposes anymore. This paper therefore investigates the causes of forest fires in Afram Headwaters forest reserve. Further, we collated data from the Ghana National Fire Service and Forest Service Division based on reports from the communities from 2002-2012 to analyze the frequency and seasonality of fire. We examined the existing management interventions to determine their effectiveness. From our study, we realized that, human are the major cause of forest fires in the Afram Headwaters forest reserve. The origin of fire could be identified as farming, hunting, smoking and other human activities carried out in the forest. Farming and hunting is the main agriculture livelihood of the people living in and around the forest. By analyzing the forest fire records (2002-2012), we were able to reveal at least 6 number of fire incidences with approximately 30 hectares of area affected annually. From the data, we identified the dry season as the period with the highest fire incidences as well as largest area burnt. January and February are the peak months of fire incidences with total burnt area of 300 hectares. Due to the dependency of local people on the forest we point out the need for effective fire management. The collaborative approach of involving communities and governmental institutions has been a step to deal with the issue. We realized the existing interventions are rather directed towards fire prevention than pre-suppression and suppression. However, several limitations were identified and addressed on those implemented fire management interventions to review the methodology, collaboration and logistical support.

Keywords: Forest, Fire, Causes, Fire occurrences, Management, Prevention, Pre-suppression, Suppression

Bio: Sandra Opoku Agyemang is a PhD student at Dresden University of Technology, Germany. She holds Dipl. and B.Sc. in Natural Resources Management (2004 and 2009) and M.Sc. Tropical Forestry and Management (2012) from Kwame Nkrumah University of Science and Technology, Ghana and Dresden University of Technology, Germany respectively. She worked with the Forest Services Division, Offinso-Ghana during her National Service. She was a field coordinator and project manager for Community Forest Management Project and Vision 2050 Forestry Ghana Limited respectively.

66. Fire and Fuels Management Tech Transfer and Training: Why Blended Learning is the only way to go

Presenter: *Piper, T. Renee, Instructional Designer, University of Idaho*
Additional Author(s):
Ernstrom, Kim, Fire Application Specialist, Wildland Fire Management RD&A
Strand, Eva, Assistant Professor, University of Idaho

Travel caps, limited training budgets and changing technology in a web-based webinar filled fire management world have caused us all to struggle with training and education in fire management. The days of travelling to standard S-courses to meet the needs of our workforce are over. Have you ever asked "what's the best method of delivery to educate our Fire Management workforce in this virtual world that we live in?" Students comment that there is too much material to cover in the estimated time or the curriculum does not engage them. With ever increasing new technology educators set expectations and deadlines but then find that a webinar just isn't the right forum to get the message across to an increasingly busy workforce with short attention spans. It's time to step into the 21st century of learning technology and put new resources to work in fire and fuels management training and education. Education no longer comes in rows and textbooks, but from a combination of sources. Designing training resources that encompass many different training delivery methodologies is called "Blended Learning". Blended Learning is integrating face-to-face classroom time with online learning; combining the effectiveness and socialization of the classroom with technology-enhanced online material. It allows us to explore the advantages of self-paced learning, while incorporating live interaction, via traditional classroom. With the flexibility of Blended Learning we are able to create a practical and meaningful learning process that works effectively since it is delivered to accommodate different learner's needs. This poster explores what is takes to use Blended Learning concepts in your fire and fuels management training resources.

Keywords: Blended Learning, Learning technology, Fire Management, Training Resources

Bio: Renee Piper is an Instructional Designer for the University of Idaho, College of Natural Resources. Her professional background in corporate and university settings focused on evaluating existing educational materials and projects possible curriculum improvements with e-learning technology. Renee specializes in Blended Learning and just recently earned a Blended Learning Certificate through American Society of Training and Development (ASTD).

67. Synthesis and Assessment of Mastication as a Fuels Reduction Treatment from 2000 to present

Presenter: *Reed, Warren, Graduate Research Assistant, Department of Forestry, Mississippi State University*
Additional Author(s):

Varner, J. Morgan, Assistant Professor, Mississippi State University
Knapp, Eric E., Research Ecologist, USDA Forest Service Pacific Southwest Research Station
Parsons, Janette, Department of Forestry & Wildland Resources, Humboldt State University

Management of fire-prone landscapes has dramatic ecological, economic, and social consequences. A variety of fuels management strategies have been applied that aim to diminish the severity and intensity of wildfire, including prescribed fire and various methods of forest thinning. The use of mechanical mastication as a fuel management technique has been increasingly utilized across a wide geographic range as well as in a variety of vegetation types. Mastication rearranges vertical ladder fuels, creating a compacted surface woody fuel structure that usually remains on site. A particular advantage of this fuel treatment is the ability to reduce fuels in areas adjacent to wildland-urban interface, where prescribed fire may not be practical due to air quality restrictions and proximity to structures or homes. Mastication has been studied from a wide scope of research objectives with a marked increase in published research since 2000. Only recently (2014) has there been a synthesis of fire effects in these novel fuels. To date, there has been no formal compilation of published scientific research focused on the efficacy, longevity, and effects of mastication on fuels and vegetation. From the literature examined, the majority has been geographically limited, focused on very few species and on relatively short time scales. We are developing an online public access bibliography as a platform to provide information on the general spatial, temporal, and topical patterns of studies focusing on mechanically masticated fuels treatments. We encourage widespread submission of ongoing research while aiming to provide a valuable, accessible, and translatable resource to land managers and researchers.

Keywords: Mastication, Fuels Treatments, Fire Effects, Literature Review

Bio: Warren Reed received his B.S. from Penn State University, studying Physical/Environmental Geography with minors in International Studies and Science, Society and the Environment of Africa. He is currently pursuing a M.S. in Forestry from Mississippi State University researching the management of fire prone regions of northern California. Broadly, Warren's research interests are fire and disturbance ecology, wildfire management, landscape ecology and climate change. Warren is the president of the newly founded Mississippi State chapter of SAFE.

68. THE SOUTHWEST FIRE SCIENCE CONSORTIUM: A GROWING OPPORTUNITY IN FIRE SCIENCE AND MANAGEMENT

Presenter: *Satink Wolfson, Barb, Program Coordinator, Southwest Fire Science Consortium*
Additional Author(s):
Thode, Andrea, Northern Arizona University School of Forestry
Fule, Peter, Northern Arizona University School of Forestry
Evans, Alexander, Forest Guild, Santa Fe, NM
Iniguez, Jose, M, USDA Forest Service, Rocky Mountain Research Station
Falk, Donald, University of Arizona, Laboratory of Tree Ring Research

The Southwest is one of the most fire-dominated regions of the US. Managers and scientists are often not aware of each other or of the external resources available. We developed a Consortium to bring parallel efforts together to be more efficient and inclusive, allowing future fire science issues to be addressed from a broader perspective with more information, more partners, and more resources. With support from the Joint Fire Science Program (JFSP), we initiated the Southwest Fire Science Consortium

(SWFSC) to promote communication and meet the fire knowledge needs of scientists and managers. We originally organized the Southwestern Fire Science Consortium around three key questions: (1) What do people need to know? Information needs are assessed through workshops, surveys, and organization of a community of practice of wildland fire professionals; (2) What information is already known? Synthesis of existing science; and (3) What are the key information gaps between what we need to know and what is already known? This question leads to the identification of critical areas for new research and management experiments. By focusing on these key questions we provide opportunities for managers, scientists, and policy makers to interact and share science in ways that can effectively move new information to management practices and facilitate new research based on management needs. To date, the SWFC has successfully brought together managers and scientists for numerous field trips and workshops to address fire science, share knowledge and science needs. The SWFSC is always looking for new ideas to disseminate fire science and reviews event and product proposals from the fire community regularly.

Bio: Barb has a Master of Science in Forestry/Fire Ecology from Northern Arizona University and has been the Program Coordinator for the Southwest Fire Science Consortium since 2011.

69. ArcFuels10 - An ArcMap toolbar for fuels management planning

Presenter: *Vaillant, PhD, Nicole, Fire Ecologist, PNW - WWETAC*
Additional Author(s):
Ager, Alan, Operations Research Analyst, PNW-WWETAC

Fire behavior modeling and geospatial analyses can provide tremendous insight for land managers as they tackle the complex problems frequently encountered in fire and fuels management including wildfire risk assessments. In the planning process, both the benefits and potential impacts of fuel treatments need to be demonstrated in the context of land management goals and public expectations. ArcFuels is a streamlined fuel management planning and wildfire risk assessment system that creates a trans-scale (stand to large landscape) interface to apply existing forest and fire behavior models within an ArcGIS® platform to design and test fuel treatment alternatives. Specifically, ArcFuels is a custom toolbar designed for use with ArcMap.

Keywords: ArcGIS, Fuel treatment planning, wildfire risk assessment

Bio: Nicole Vaillant is a fire ecologist at WWETAC and has worked for the Forest Service since 2001. She received a Ph.D. and M.S. in environmental science, policy, and management at the University of California, Berkeley, and a B.S. in evolution and ecology from the University of California, Davis. Prior to coming to WWETAC Nicole worked as a seasonal wildland firefighter, including a season with the Redding Hotshots, and was a fire ecologist with Adaptive Management Services Enterprise Team. Her current interests include characterizing fire behavior at multiple scales, fuel treatment effectiveness, and wildfire risk assessments.

70. Impacts of Large Wildfires on Units within the Intermountain Region of the National Park Service

Presenter: *Duhnkrack, Jesse, Wildland Fire Management Specialist, National Park Service*

There has been a measureable increase over the past two decades in large wildfires occurring near or emanating from adjoining lands onto units in the Intermountain Region of the National Park Service (NPS). A wide range of impacts and fire effects have resulted from these wildfires.
This poster examines both the positive and negative impacts of these fires, as well as possible explanations for this trend, including, but not limited to drought, ecological factors, fuel conditions, climate change, and fire suppression strategies. Using spatial data combined with tabular fire records, the poster displays the occurrence of large fires that have burned near or onto NPS lands. If the trend continues, it will become increasingly important for all stakeholders to embrace the goals of the National Cohesive Wildland Fire Management Strategy in order to reduce adverse impacts.
The occurrence of large wildfires will continue to be an important factor in wildland fire management planning for the NPS. In the future, the priorities for the NPS wildland fire management program are likely to focus on areas where the historic fire regime has created landscape scale changes, and mitigate risk where wildfires occur on a frequent and regular basis. The NPS Wildland Fire Management Program is dedicated to protecting lives, property and resources while restoring and maintaining healthy ecosystems.

Keywords: planning, parks, cohesive strategy, strategic

Bio: After earning a Bachelor of Science degree in Environmental Science from Huxley College at Western Washington University, started a career in wildland fire management with the USDA Forest Service. Hired by the National Park Service in 1982 as Hotshot crewmember. Many years of mid-level program leadership at Yosemite, Sequoia, and Grand Canyon National Parks. Served as FMO at Rocky Mountain National Park from 1997 to 2005. Currently working for the Intermountain Regional Office in Lakewood, Colorado, and responsible for strategic planning, firefighter safety, training, and a variety of operational issues.

71. Forecasting Distribution of Numbers of Large Fires

Presenter: *Eidenshink, PhD, Jeff, Fire Science Team Leader, USGS EROS*
Additional Author(s):
Preisler, Haiganoush, Statistical Scientist, USFS Pacific Southwest Research Station
Burgan, Robert, USFS Retired
Howard, Stephen, Senoir Scientist, USGS EROS

Systems to estimate forest fire potential commonly utilize one or more indexes that relate to expected fire behavior; however they indicate neither the chance that a large fire will occur, nor the expected number. That is, they do not quantify the probabilistic nature of fire danger. In this work (paper?) we use large fire occurrence information, from the Monitoring Trends in Burn Severity project, and the Fire Potential Index, derived from satellite and surface observations of fuel conditions, in a statistical model for estimating two aspects of fire danger: 1) the probability that a one acre ignition will result in a 100+ acre fire, and 2) the probabilities with which to expect at least 1, 2, 3, or 4 large fires within a Predictive Services Area in the forthcoming week. These statistical processes are the main thrust of the paper and both produce daily national maps that are available from the EROS Data Center via the Wildland Fire Assessment System (WFAS). A validation study of our maps for the 2013 fire season demonstrated good agreement between observed and forecast values.

Keywords: Fire danger, Forecasting

Bio: Dr. Jeff Eidenshink is a Physical Scientist at the U.S.G.S. Earth Resources Observation and Science (EROS) Center. He has been involved in remote sensing and GIS research for over 30 years and has worked in the research and development environmental data sets from satellite observations and application of remote sensing technology in fire science. Recent research is focused on the use of satellite remotely sensed data to characterize wildland fire potential, fire burn severity and to monitor burn area recovery. This activity includes the development and enhancement of a USGS EROS service that provides geospatial information products to DOI and other local and federal land managers.

72. Large Fires in San Diego County, California

Presenter: *Eisele, Bob, Watershed Manager, Retired, County of San Diego*

San Diego County, California has been the epicenter for large destructive wildfires since fire perimeter records have been kept. This paper analyses the weather, fuels, topographical features, and ignitions of all large fires (over 4,000 ha) since 1910 including the 1970 Laguna fire, 2003 Cedar and Paradise fires, and the fire siege of 2007 with Harris, Witch, and Poomacha fires. Of special interest, the report looks at some fires in 2007 which started in younger fuels and were easily extinguished by fire suppression forces in spite of extreme weather conditions.

- Weather was divided into foehn wind driven fires and fires that occurred under the influence of summer high pressures heat waves.
- The age and type of the vegetation at the section of origin was obtained and analyzed.
- Examination of fuel age and type was used as a surrogate for the effectiveness of prescribed fire in moderating large fires. Vegetation age and structure loss was tested for any correlation.
- Rainfall amounts in previous years and PDSI was tested for relationship to acres burned.
- Ignitions were examined using geospatial regression analysis to determine if extra effort in areas with frequent ignitions would help limit large fires.

Keywords: large fires, fuel age

Bio: Bob Eisele is retired from the County of San Diego Fire Authority where he conducted prescribed fires for over 20 years. He has been the Fire Behavior Analyst on Southern California Incident Management Team 2 since 1999.

73. Temperate and boreal forest mega-fires: characteristics and challenges

Presenter: *Ingalsbee, Timothy*

Additional Author(s):
Scott L Stephens, Neil Burrows, Alexander Buyantuyev, Robert W Gray, Robert E Keane, Rick Kubian, Shirong Liu, Francisco Seijo, Lifu Shu, Kevin G Tolhurst, and Jan W van Wagtendonk

Mega-fires are often defined according to their size and intensity but are more accurately described by their socioeconomic impacts. Three factors – climate change, fire exclusion, and antecedent disturbance, collectively referred to as the "mega-fire triangle" – likely contribute to today's mega-fires.

Some characteristics of mega-fires may emulate historical fire regimes and can therefore sustain healthy fire-prone ecosystems, but other attributes decrease ecosystem resiliency. A good example of a program that seeks to mitigate mega-fires is located in Western Australia, where prescribed burning reduces wildfire intensity while conserving ecosystems. Crown-fire-adapted ecosystems are likely at higher risk of frequent mega-fires as a result of climate change, as compared with other ecosystems once subject to frequent less severe fires. Fire and forest managers should recognize that mega-fires will be a part of future wildland fire regimes and should develop strategies to reduce their undesired impacts.

Bio: Ingalsbee, Timothy, Ph.D. is the executive director of Firefighters United for Safety, Ethics, and Ecology (FUSEE), co-director of the Association for Fire Ecology, and an adjunct instructor and faculty research associate in Environmental Sociology at the University of Oregon. Timothy served as a wildland firefighter for the U.S. Forest Service and National Park Service. In 1993 Timothy received the Oregon Conservationist of the Year Award. In 2002, he served on the Western Governors' Association's stakeholder group for the Ten-Year Comprehensive Wildfire Strategy and National Fire Plan. Timothy is a senior wildland fire ecologist certified by the Association for Fire Ecology.

74. Supporting strategic and tactical wildfire decisions with operational simulations

Presenter: *Ramirez, Joaquin, MsC WILDLAND FIRE SCIENCE AND INTEGRATIVE MANAGEMENT (MasterFUEGO), GRAF (Catalonia, Spain), MasterFUEGO*
Additional Author(s):
Castellnou, Marc. Wildland Fire Analyst Chief, GRAF (Catalonia Fire Service)
Ramírez, Joaquín. MasterFuego (Universidad de Leon) and Technosylva Inc, San Diego

The new fire generations, the so called 3rd, 4th and 5th by Castellnou (2010), are characterized by simultaneous extreme behavior fires spreading in the Wildland Urban Interface. During these fires it is a critical factor to the take the best decisions in the first burning periods, to avoid them burn all their potential.

The Wildland Fire Analyst (Molina et al, 2010) is a new profile that has an increasing relevant role in many European agencies, studying the local fire behavior and understanding the propagation patterns related to different terrain and weather scenarios.

Together with this new generation of professionals, the use of geotechnologies in wildland fires are becoming a key tool to operational support. The new generation of operational simulators try to provide answers in real time about the expected extreme fire behavior in the front line environment, before the extended attack resources come to provide a bigger but later support. Integrating the increasing fire observation capabilities in the simulators, provides relevant data to real time calibrate the results of the expected milestones that will drive more efficient strategies and tactics.

The proposed methodology is focused in wildfire analysis and operations, relating the simulator Wildfire Analyst (Ramirez& Monedero, 2009), with the strategy and tactic concepts. The objective is to obtain fast and simple simulations to support strategic and tactical decisions in the first burning periods, and reduce the fire potential from the beginning. It simulates the fire in sections, evaluating the fire potentials and the trigger points in every section. It is thought to be used in real time; during the fire is spreading, to help the Wildland Fire Analyst to take the most appropriate decisions.

Several examples of the application of the present methodology in fires both in Catalonia and Southern California in 2012 and 2013 will be presented.

Keywords: Wildland Fire Analyst, Strategy, Tactics, Large Fire, Simulators, Wildfire Analyst

Bio: Llorenç Castell is 24 year old guy, from the south of Catalonia, Spain. He studied the foresty bachelor in the University of Lleida and he specialized in wildland fire management studying the MasterFuego in the University of Lleida, University of Leon and the University of Córdoba. He worked in wldfire seasons in the Catalonia Fire Service, since 2013 in GRAF.

75. Forest Cover After the High Park Fire: Landscape-scale Restoration or Novel Vegetation Pattern?

Presenter: *Rocca, PhD, Monique, Associate Professor, Dept. of Ecosystem Science and Sustainability, Colorado State University*
Additional Author(s):
Filippelli, Steven, M.S. student, Graduate Degree Program in Ecology, Colorado State University
Lefsky, Michael, Associate Professor, Dept. of Ecosystem Science and Sustainability, Colorado State University
Romme, William, Research Scientist, Natural Resource Ecology Laboratory, Colorado State University
Sibold, Jason, Assistant Professor, Dept. of Anthropology, Colorado State University
Stone, Brandon, M.S. student, Graduate Degree Program in Ecology, Colorado State University

The High Park Fire burned through 35,000 ha in Northern Colorado in 2012, and inflicted significant devastation on local communities and water supplies. Unlike several other recent fires in montane forests along the Colorado Front Range, however, the High Park Fire left behind a remarkably patchy pattern of tree mortality. We compared maps of forest cover from 1930s, 2011 (pre-fire), and 2012 (post-fire) to ask: How much, and where on the landscape, did forest cover change between the 1930s and 2011? To what extent did the 2012 fire re-establish historical patterns of forest cover? In which respects did the fire create novel vegetation patterns on the landscape? Previous attempts to extract forest cover from historical aerial photos have been complicated by shadows and excessive off-nadir camera angles, both of which tend to cause overestimation of historical forest cover. We developed a new approach for mapping historical forest cover by obtaining canopy height from surface models based on historical aerial photographs and lidar-based ground models. We will describe our approach and demonstrate, using the High Park Fire as a case study, how our methods can be used to assess the potential for large wildand fires to achieve landscape restoration objectives. We will conclude with some insights about if, when, and where large wildland fires might have unexpected resource benefits.

Keywords: remote sensing, forest cover, restoration, large wildfire

Bio: Monique's areas of expertise include fire ecology and management, forest restoration, plant community ecology, and landscape ecology. Ongoing projects focus on understanding the "future forest" following pine beetle outbreaks, recent wildfire, forest thinning treatments, and climate change. Monique is a professor at Colorado State University, where she teaches courses in forest ecology, fire ecology, and wildland fire management. Monique has a bachelor's degree in Biology from Stanford University, and a Ph.D. in Ecology from Duke University.

76. Burn Severity Assessment of the Bastrop Fire Complex using Differenced Normalized Burn Ratio

Presenter: Tiller, Michael, Graduate Student, Stephen F. Austin State University
Additional Author(s):
Unger, Daniel, Associate Professor, Stephen F. Austin State University
Oswald, Brian, Joe C. Denman Distinguished Professor, Stephen F. Austin State University

Burn severity assessments using Landsat 7 TM/ETM+ imagery with the Differenced Normalized Burn Ratio (dNBR) has become a standardized remote sensing procedure utilized by federal land management agencies to monitor post wildfire and prescribed fire treatment effects. Rapid assessments of burn severity data can be a critical element of the post fire rehabilitation planning process that can address urgent soil stability concerns in topographically compromised urban areas and sensitive ecosystems. Burn severity data can further be utilized to evaluate the effectiveness of prescribed fire treatments or wildfire impacts associated with fuels reduction programs, wildlife habitat restoration, and watershed condition. The Bastrop Fire Complex that burned in the 2011 fire season was recorded as Texas's most destructive wildfire event to date in terms of structure loss (1,660 homes) and firefighting resource commitments to the Wildland-Urban Interface (WUI). Extreme fire behavior not only engulfed an unprecedented amount of urban dwellings, but severely impacted a unique ecosystem containing the endangered Houston toad (Bufo houstonensis) and an isolated stand of drought resistant loblolly pine (Pinus tadea) species known as the "Lost Pines". In response to both the ecological and WUI implications of the Bastrop Complex Fire, an initial burn severity assessment utilizing Landsat 7 ETM+ imagery according to the dNBR ratio protocol was created to gain a better understanding of wildfire impacts to local loblolly pine stands, wildlife habitats, and future WUI planning concerns within the Bastrop county region of Central Texas.

Bio: Michael began his career with the California Department of Forestry and Fire Protection in Northern California where he served fifteen years as a firefighter and fire apparatus engineer. After his fire service career, he attended Texas A&M University and received a B.S. degree in Wildlife and Fisheries Management. Michael is currently attending Stephen F. Austin State University where he is pursuing an M.S. degree in Environmental Science with an emphasis on fire ecology.

77. Extremes in Fire – The Intersection of Climate, Fuels and People

Presenter: *Wall, PhD, Tamara, Assistant Research Professor, Desert Research Institute*
Additional Author(s):
Brown, Timothy J., Research Professor, Desert Research Institute
Sexton, Tim, Program Manager, USDA RMRS Science Application

Over the past decade or so, statements by fire personnel claiming unusual fire behavior beyond training or experience levels seem to be increasing. This is not strictly occurring in the U.S., as Australia and European countries, for example, are claiming similar changes fire behavior. Concurrently with this increase of claims, climate change has been occurring, fuel loads have notably increased due to both natural occurrence and management practices, and the WUI has been expanding. All of these factors appear to be merging to cause an increase in "extreme" fire events based on another fire triangle of climate, fuels and people. Megafires (for those comfortable with the term and lack of official definition) could be considered the extreme of the extremes, as well as many large fires. Sometime the surprise is how large fires become. But for these extreme events to occur, not all three factors on the triangle need

necessarily be extreme simultaneously. For example, strong winds need not be out of the ordinary (e.g., Santa Ana), but combined with continuous and heavy fuel in a highly populated area can lead to "never seen before" occurrences. In some cases, the extreme event is truly a surprise; in other cases, while seemingly a surprise at the time, upon further reflection perhaps it should not have been. In either event, personnel safety can easily be at higher risk during extreme events, as these situations tax critical thinking given they are outside the common fire experience.
The project discussed in this presentation draws upon quantitative assessment of physical observations (e.g., climate, weather, fuels) along with qualitative assessment of firefighter claims to 1) determine if indeed there is a common trend and merging of these factors; 2) determine if situational awareness factors can be identified to lessen the surprise of these events; and 3) provide recommendations that incorporate knowledge of extreme events into fire management training. The qualitative methodology we are employing is a data collection and analysis system that allows individuals to describe extreme fire events in their own words and collect a range of experiences over time. The intent is to gather both past experiences from fire professionals throughout the United States through the 2014 fire season.

Bio: Dr. Tamara Wall is currently an assistant research professor at the Desert Research Institute and works with the Western Regional Climate Center and the Program for Climate, Ecosystems, and Fire Applications. She recently completed her postdoctoral fellowship with the California-Nevada Applications Program (CNAP), part of the national NOAA-sponsored RISA (Regional Integrated Sciences and Assessments) network and continues to work with CNAP.

78. An Investigation of LandScan Suitability for Strategic Decision Making in the Wildland Fire Decision Support System

Presenter: *Butler, Benjamin, WFDSS GIS Specialist, Wildland Fire Management RD&A*
Additional Author(s):
Bailey, Andrew - Data Manager, Wildland Fire Management RD&A

The Wildland Fire Decision Support System (WFDSS) is a data rich application that graphically displays spatial data and information to assist fire managers and analysts in making strategic, risk-based decisions for wildland fire incidents. Understanding where buildings are located and where people live is a critical piece of information for the development of risk-informed management strategies. WFDSS has partially filled this need by developing and maintaining a “building cluster” data layer. Building clusters are tax parcel centroids where the parcel improvement value indicates the presence of a building. These data indicate the presence of property in need of protection from wildland fire, but they do not tell the whole story. The incorporation of the LandScan USA dataset in HSIP Gold provides a potential supplement to an infrastructure-centric view of risk. LandScan USA augments census block-level population measures with the spatial precision of 90-meter pixels from satellite images of night-time lights. The incorporation of population data into WFDSS could provide an assessment of risk to population by wildland fires consistently across the United States.
A comparative analysis was conducted to investigate the suitability of LandScanTM data for use in WFDSS to aid in making risk based strategic decisions. Specifically, the analysis investigated the correlation between where buildings are located according to the building cluster data and where they live/spend their time according to LandScanTM. WFDSS Incident Planning Areas were used to define the sampling areas in the study and all Planning Areas in WFDSS that returned positive building cluster point counts were used in the analysis. A total of 1,972 Planning Areas and Values Inventory results were

explored and compared to three the different LandScanTM data products (daytime, night, and ambient population distribution).

Keywords: WFDSS, Spatial Data, Strategic Decision, LandScan, Population, Analysis

Bio: Ben Butler is the Wildland Fire Decision Support System (WFDSS) GIS Specialist. Based in Boise, ID at the National Interagency Fire Center (NIFC) Ben's position is within the Wildland Fire Management RD&A (WFM-RD&A). His responsibilities include the management of WFDSS geospatial data, integration of disparate interagency data sources into single data sets, and technical GIS support within the WFM-RD&A and to WFDSS.

With an undergraduate degree in geography/GIS and a Master of Natural Resources degree with a concentration in fire ecology, Ben's interests and experience emphasize leveraging geospatial technologies to solve natural resource and wildland fire issues.

79. Aboriginal Wildfire Evacuation Partnership

Presenter: *Christianson, PhD, Amy, Fire Social Scientist, Natural Resources Canada, Canadian Forest Service*
Additional Author(s):
McGee, Tara, Department of Earth and Atmospheric Sciences, University of Alberta

Thousands of Canadians are evacuated from their homes every year in order to protect the health and safety of residents during wildfires. Despite comprising only 4% of the Canadian population, almost 1/3 of wildfire evacuations between 1980 and 2007 involved Aboriginal people. In 2011, thousands of residents in 35 Aboriginal communities in Alberta, Saskatchewan and Ontario were evacuated for up to three weeks due to the close proximity of fire, smoke, and power outages due to wildfires. Some residents were evacuated to nearby host communities and others were evacuated to towns and cities located a considerable distance away. This partnership brings together researchers, Aboriginal communities in Ontario, Saskatchewan and Alberta that were evacuated due to recent wildfires, and agencies responsible for conducting or providing support during these evacuations. The aim of this partnership is to examine how Aboriginal residents and communities have been affected by wildfire evacuations and identify ways to reduce negative impacts of wildfire evacuations on Aboriginal people. A qualitative approach is being used to achieve the aim of understanding people's wildfire evacuation experiences. Research is currently being carried out with six partner communities: Dene Tha First Nation (Alberta), Driftpile Cree Nation (Alberta), Onion Lake Cree Nation (Saskatchewan), Mishkeegogamang Ojibway First Nation (Ontario), Sandy Lake First Nation (Ontario), and Deer Lake First Nation (Ontario).

Keywords: Evacuation, Aboriginal, Indigenous, wildfire, Canada

Bio: Amy Christianson is a Fire Social Scientist for the Canadian Forest Service from Edmonton, Alberta, Canada. Her expertise is in contemporary Aboriginal wildfire management.

80. Forest Jihad?: The Threat of Religious-Inspired Pyro-Terrorism in U.S. Forests and Abroad

Presenter: *French, Diane, M.A. Candidate, Johns Hopkins University Paul H. Nitze School of Advanced International Studies (SAIS)*

While modern-day security policies largely focus on the threat of weapons of mass destruction (WMD) in urban areas, the so-called "War on Terror" has also brought a new threat to Western soil – "forest jihad," or the religious-inspired use of pyro-terrorism in forested landscapes and wildland-urban interface regions. The United States is no stranger to fire wars and arson attacks in forested areas, having been both the target and executor of such tactics during World War II and the Vietnam War, respectively. More recently, however, the U.S. has been the target of individual acts of arson by non-state organizations and individuals pursuing political, social and religious aims. This new wave of pyro-terrorism has been most frequently carried out by domestic environmental activists, yet evidence points to an increasing threat from radical Islamic fundamentalist organizations, such as al Qaeda, seeking retaliation for the presence of American and allied troops in Iraq and Afghanistan. Indeed, when Navy SEALs killed Osama bin Laden in 2011, they captured numerous al Qaeda plans including a detailed campaign for starting fires throughout the American West. One year later, al Qaeda's online English-language magazine, Inspire, published an article titled "It is of your freedom to ignite a firebomb," which offers detailed advice for starting large forest fires in the U.S. with nothing more than a timed explosive device. Not only do such strategies require minimal cost, coordination and effort, forests provide a logical and vulnerable target due to the potential for large-scale physical, economic and psychological destruction; the sustained timescale and range of impact of wildfires; the impossibility of thoroughly protecting large, forested lands; the challenge of coordinating a concerted response from multiple accountable authorities; and the difficulty of such authorities to successfully determine not only the cause, but the perpetrator, of the incident. Throughout the last decade, incidents and evidence of forest-based pyro-terrorism have been publically acknowledged in Israel, Spain, Greece, Estonia, Australia, and the U.S. With destructive force rivaling that of a nuclear weapon, and compounded environmental consequences for deforestation and climate change as well as political, social, psychological and economic effects, wildfires deserve a more prominent position in the national security dialogue and doctrine of the U.S. and her allies. The threat of forest jihad necessitates enhanced coordination in wildfire response and prevention tactics, as well as an overarching change in mindset to frame such incidents as national security threats, rather than simply land-management issues.

Keywords: Pyro-terrorism, forest jihad, fire war, arson, wildland-urban interface, national security, War on Terror, al Qaeda, weapon of mass destruction (WMD)

Bio: Diane French is a student at the Johns Hopkins University Paul H. Nitze School of Advanced International Studies (SAIS) in Washington, DC, where she is pursuing a Master of Arts degree in International Relations and International Economics with a concentration in Energy, Resources and Environment. She received a Bachelor of Arts degree in Politics from Princeton University ('12), where she concentrated in International Relations and obtained a certificate degree in Near Eastern Studies. Prior to attending graduate school, she worked in the White Mountain National Forest of New Hampshire and the 100-Mile Wilderness of northern Maine with the Appalachian Mountain Club, the nation's oldest outdoor recreation and conservation organization. She hopes to combine her passion for the outdoors with her background in security studies to pursue a career in Environmental Security.

81. Examining the Effect of Environmental Change in Determining Fire Evacuee's Responses to Natural Disasters

Presenter: *Gerweck, Deanna, Student, University of Colorado, Colorado Springs*
Additional Author(s):
Cerian Gibbes, Assistant Professor, University of Colorado Colorado Springs

This study examines the relationship between geographic factors, the environment, and homeowner responses to natural disaster in a neighborhood affected by wildfire. The study area is located near the South Lake Tahoe Basin in California where the Angora Fire burned 3,100 acres in June of 2007. Utilizing a remote sensing based exploration, vegetation and landscape patterns are analyzed to determine the role of environmental change in determining fire evacuees' responses. Using survey data measuring efficacy, this study examines the relationships amongst environmental changes, individual and community preparation for fire hazards, and the ability of homeowners to cope with fire related loss. Over a period of 9 years, this research assesses landscape changes. This time span allows for determination of spatial and temporal variation in vegetation patterns before the fire, right after the fire – measuring the intensity of the burn - and during the restoration of the vegetation up to five years after the fire. During the Angora Fire, 242 homes were destroyed in 16 days, making this study pertinent to research areas such the wildland urban interface, societal response to natural hazards, and fire policy.

Keywords: Angora Fire, Remote Sensing, Evacuee Response

Bio: Deanna is in her final year of obtaining a Bachelor's degree in Geography and Environmental Studies from University of Colorado at Colorado Springs. She is on the geospatial track exploring Geographic Information Science through Remote Sensing and other Geographic Information Systems. Deanna is interning with the Colorado Springs Fire Department under the Wildfire Mitigation Unit and producing relevant and current maps of the Wildland-Urban Interface in Colorado Springs. Deanna's future goals include completing her bachelor's degree with a certification in GIScience and obtaining a career with the United States Geological Survey (USGS) to analyze physical environments using geospatial technologies.

82. Post-Wildfire Landscape Recovery: Perspectives from Remotely Sensed Images and Social Science Data

Presenter: *Kooistra, Chad, PhD Candidate, University of Idaho*
Additional Author(s):
Hall, Troy, Professor, University of Idaho, Conservation Social Sciences Department
Paveglio, Travis, Assistant Professor, University of Idaho, Conservation Social Sciences Department

Wildfires have short and long-term social and ecological impacts that change the landscape's structure, function, and appearance to some extent. Many people are particularly affected by the aesthetic impacts from wildfires, often describing a sense of loss after the landscape they value changes from live vegetation to charred soils and vegetation. Biophysical scientists study the role of wildfires in ecosystems and how the landscape changes after wildfires. One area of research is understanding the process of how landscapes do or do not recover to pre-fire conditions. Characteristics of the landscape like vegetation composition and distribution, soil chemistry, and water quality are monitored to track how the landscape recovers in post-wildfire conditions. Many climatic, pre-fire forest conditions (e.g.,

fuel load and history of fire and fire suppression), and characteristics of the wildfire (e.g., burn severity) affect how a landscape recovers. Land managers often invest significant resources into post-wildfire restoration efforts based on achieving management goals like erosion control, invasive species prevention, and achieving ample timber stand density. Studies have shown that the public generally supports these post-wildfire activities. However, less is known about how people experience the changing landscape and perceive landscape recovery over time. This poster presents research that uses remotely sensed images and social science interviews to help understand public perceptions of post-wildfire landscape change and recovery. Interviews with residents near Roundup, MT in 2013 about the 2012 Dahl fire revealed that when discussing landscape recovery from the Dahl fire, many residents relied on their experiences with the nearby 1984 Hawk Creek fire and the 2006 Majerus Road fire, specifically how different climatic and managerial influences affected the landscape recovery in those areas. Given the subjective nature of the general public's mental models of landscape recovery due to varying levels of knowledge about ecosystem processes, as well as different degrees of relationships with the landscape (i.e., sense of place considerations), we analyzed Landsat images and aerial photographs (provided by the National Agriculture Imagery Program) of each of the three wildfires to get a more objective measure of the short and long-term landscape changes. Integrating the different data sets allowed for a unique and in-depth understanding of the similarities and differences between actual post-wildfire changes in the landscape and the public's perceptions of those changes. We present the implications of this research for communication and management efforts based on our integrated approach to understanding post-wildfire landscape recovery perceptions.

Keywords: public perceptions, landscape recovery, wildfire impacts, social science, remote sensing, landscape change, public attitudes

Bio: Chad earned his B.S. in Natural Resource Recreation and Tourism at Colorado State University in 2005. After working a few years for federal and NGO land management agencies in Colorado and Nevada, he earned his M.S. from the CSS Department in December 2011 studying Colorado residents' attitudes towards forest management after a widespread pine beetle outbreak. His PhD research, supported by a NASA grant, seeks to understand people's perceptions of landscape change and recovery after wildfires. He intends to pursue a professional career teaching and conducting research about human dimensions of natural disasters.

83. Creation and implementation of a certification system for insurability and fire risk classification for forest plantations, to improve sectorial asymmetries and raise competitiveness of small and medium companies (SMEs)

Presenter: *Loewe, MPA, Veronica, Forest Engineer, INFOR*
Additional Author(s):
Vargas Victor, Forest Engineer, INFOR
Ruiz Juan Miguel, Civil Engineer, FORESTSUR
Alvarez Andrea, Agronomist, INFOR

Currently the Chilean insurance market sells forest fire policies and agricultural weather risks policies. Nevertheless, forest SMEs can barely get fire insurance policies for forest plantations because the insurance market is small and there is poor information about SMEs, assigning a high risk qualification that difficult hiring policies, increasing its cost because of the uncertainty. So there are serious barriers

for forest SMEs due to the lack of standardized information, affecting 18.000 owners and 810.000 plantations hectares.

This reality is being faced with a project funded by the Chilean Foundation for Agriculture Innovation (FIA), along with Government institutions, forest companies, insurance companies, insurance adjusters and brokers, and executed by the Chilean Forest Institute (INFOR), with a total budget of approximately US$ 410.000, that will be allocated in 3 years (2013-2016).

The Solution
A certification system of fire risk classification for forest plantations (named SAFOR per the Spanish acronym), will be created and implemented, allowing the SMEs access to the insurance market.
The solution has got two elements, the standard, built as a formal national norm by the Chilean Standardization Institute (INN) that describes objectively how to evaluate the risk, and the certification system that will transfer into the market the compliance with the norm based on an appropriated accreditation of auditors through the fulfillment of certain procedures, which will ease the fire policies buying process. The insurance market will adopt the certification system as a source of information to qualify fire risk associated to policies, and the clients will pay the certification to break the entrance barriers by evaluating the risk, which should decrease policies price and increment the total transaction volume. It will be implemented experimentally in the market.

Benefits and Impacts
This solution will allow for forest SMEs hiring fire policies at sustainable prices, according to the forest activity, and thus the insurance market will grow after the adoption of the SAFOR certification since it will be recognized as a reliable source of information when evaluating fire risks.
It is expected that the implementation of SAFOR certification will improve several indicators.
Forest companies with plantations close to SMEs plantations will also be benefited because of the decrease of fire incidence.

The reduction in quantity of fires will contribute to the environment and also to the State investments, since owners of plantations established with State contribution could continue in the forest business after a fire, preserving the rural economy.

Keywords: Fire plantation risk evaluation, Fire insurance, SMEs and fire

Bio: Extensive senior-level experience in research, management and policy making on natural resources and sustainable development. Demonstrated record in improving organizations through innovative administration. Expertise in R&D&I project formulation and management. Fluent in Spanish, English, Italian and French; Technical Portuguese.

84. A spatial analysis of wildfire risk to Alberta's drinking-water supply

Presenter: *Robinne, François-Nicolas, PhD student in forest biology and management, University of Alberta, Western Partnership for Wildland Fire Sciences*
Additional Author(s):
Flannigan, Mike, PhD, University of Alberta
Parisien, Marc-André, PhD, Canadian Forest Service
Bladon, Kevin, PhD, University of Alberta

Wang, Xianli, PhD, University of Alberta
Silins, Dr. Uldis , Professor, Forest hydrology and watershed management, University of Alberta, Canada
Emelko, Dr. Monica B., Associate Professor, Water Quality Engineering and Wastewater Treatment, University of Waterloo, Canada

Forested regions are the primary source of surface-water supplies supporting Alberta's population. In this area, wildfires are the main natural disturbance and a predicted increase in their magnitude, in conjunction with a sharp rise in population, will invariably exacerbate the risk to the drinking water supply. The purpose of our work is to produce a province-wide spatial risk-analysis framework linking wildfire threats to drinking water treatment operations in Alberta. Wildfire hazard characterization was based on the analysis of historical fire activity. We developed a statistical model of fire occurrence based on climate normals, extreme fire weather, physiographic, and anthropogenic variables. Based on modelling results, we evaluated the threat to water supply by estimating the potential discharge of post-fire contaminants in each of the province's watershed. Subsequently, we parameterized a hydrological model for a prediction of downstream changes in contaminant concentration. Finally we linked the predicted changes in water quality to the potential impact on water-treatment facilities to define the risk of drinking-water supply failure. Our results show that the highest threat on water supply mainly comes from watershed of the Rocky Mountains and the foothills. Wildfire probability is not high in these areas, but the much greater water yield and the relatively high population in the wildland-urban intermix could lead to extreme post-fire impacts. Conversely, wildfire probability in the boreal forest is high but the associated water supply vulnerability is currently low, leading to a low-level risk. Nevertheless, the projected increase in urban and industrial development of northern lands might lead to a rise of the water demand in the incoming decades, which will consequently lead to a rise of the risk. This developed framework will serve as a template applicable to other regions of Canada or elsewhere for evaluation of risks to provision of safe drinking water and design of mitigation strategies.

Keywords: fire occurrence, post-fire impacts, drinking-water supply

Bio: François-Nicolas Robinne is a PhD student in Forest Biology and Management at the University of Alberta, Canada. He is a part of the Western Partnership for Wildland Fire Sciences where he works on the integration of wildfire risk into watershed management. He received his BSc in Environmental Geography and his MSc in Natural Risk Management at the University Paul Valéry in France. After that, he worked as a geomatics professional in the forestry private sector.

85. Journalism for Scientists

Presenter: *Vosburgh, Mark, Physical Scientist, USFS Rocky Mountain Research Station*

This session will provide examples of how scientists can expand the impact of their research by working with journalists.

Real world case studies with perspectives of professional scientists and journalists will be presented. Roadblocks to successful outcomes resulting from differences in scientific and journalist cultures will be covered.

Keywords: journalism

Bio: Mark Vosburgh is a Physical Scientist with the Missoula Fire Sciences Laboratory. A chemical engineer by training, he has over 20 years of experience with fortune 500 companies prior to joining the USFS. In both his public and private sector careers, he has worked to effectively communicate solid technical information to inform and influence a generally non technical public.

86. Forest fuel ignition by focused sunrays

Presenter: *Baranovskiy, PhD, Nikolay, Assistant Professor, National Research Tomsk Politechnic University*

Ignition of a forest fuel is important stage of forest fire occurrence. Forest fuel ignition probable as a result of the various reasons, including as a result of focused sunrays action. Glass containers, their splinters and large drops of coniferous trees pitch can be the solar energy concentrator. Authors suggest that more effectively to predict forest fire danger, instead of to struggle with forest fires. It is necessary to develop the forest fire danger prognostic modeling technology. Research objective is development of mathematical technologies of forest fire danger caused by focused sunrays forecasting. Development of forest fuel ignition mathematical models is impossible without leading of physical experiments on forest fuel ignition by the focused sunrays. Numerous experiments in territory of Timirjazevskiy timber enterprise of Tomsk areas (Russian Federation) have been made in 2012 – 2013 years. Samples from pine needles, grassy rags and birch leaves were objects of research. Experiments have shown, that the pine needles are most easier ignited. Grassy rags ignites more difficultly. Birch leaves in the specified conditions were not ignited. Concave-convex optical glass lens was used as solar energy concentrator. Ignition delay times of typical forest fuel types have been defined. Physical model of forest fuel ignition process by the focused sunrays is developed on the basis of the experiment results analysis. Mathematical model of forest fuel ignition by the focused sunlight is developed on the basis of physical model. Mathematical model is presented by system of the non-stationary nonlinear equations of heat conductivity and diffusion. Comparison of numerical simulation results and experimental data on forest fuel ignition by focused sunrays is spent. Obtained results make a basis of new forest fire danger prognostic modeling technology.

Work is executed with financial support of the Federal target program «Scientific and scientific and pedagogical staff of innovative Russia» on 2009 - 2013 (action 1.5). The agreement № 14.B37.21.1979.

Keywords: forest fuel, ignition, focused sunrays, glass lens, experiment, mathematical simulation

Bio: Baranovskiy Nikolay Viktorovich was born on April, 13th, 1978 in Tomsk (Russian Federation). He is left municipal school № 47 of Tomsk in 1995. Then has entered on the faculty of mechanics and mathematics of Tomsk state university. In 2000 has graduated from the university and has entered in postgraduate study. Since 2005 worked as younger research assistant at Scientific research institute of applied mathematics and mechanics. In 2007 has presented the Ph. D. dissertation of the candidate of science in physics and mathematics on a theme «Mathematical modelling of the most probable scenarios and conditions of forest fires occurrence». Since 2008 training in doctoral studies of National research Tomsk polytechnic university. Since 2011 on the present time he works at Power institute of Natioanl research Tomsk polytechnic university as the Assistant professor.

87. Evaluating Sprinkler Efficacy for Wildland Fire Protection Programs in Fairbanks, Alaska

Presenter: *Barnes, RPF, Devon, Masters of Science Candidate, University of Alberta*
Additional Author(s):
Flannigan, Mike, Professor, University of Alberta
Miller, Eric, Fire Ecologist, Bureau of Land Management

Many fire agencies goal is to allow fires opportunity to burn freely while maintaining protection of values at risk. To meet these objectives a new strategy to fire control is necessary. This is particularly important as wildland fire management organizations reach their resource limits of people, pay and equipment. Sprinkler protection programs alleviate fire resource scarcity by reducing the resources required per unit area. The area protected by each sprinkler can be extrapolated for strategic fire management planning.

The immediate protection from sprinklers by wetting the fuel surface is known, but the water saturation effect is rarely considered. How much sprinkler watering is needed to treat a given fire hazard? This study evaluates sprinklers' ability to alter fuel moisture content in Boreal forests around Fairbanks, Alaska. The experiment tested a variety of sprinkler watering treatment levels at eight research sites. Each research site contained twelve treatment plots having four subsample stations. The subsample stations measured the amount of water received (independent variable) and the change in fuel moisture content (dependent variable). The moisture contents are then converted into Fire Weather Index (FWI) values to show the fire hazard reduction.

The research intent is to counteract moisture loss using sprinklers to mitigate drought stress in live and dead fuels to inhibit combustion. The results indicated watering treatment effectiveness to a point of diminishing return. A regression curve is developed to quantify the water use efficiency of the sprinkler treatments. This information will allow fire managers to control when and where wildland fires can occur.

Keywords: Sprinkler protection, Fire Weather Index, Fuel moisture content

Bio: During Devon's undergraduate education, he spent his summers working on an initial attack fire crew. In 2009, Devon graduated from Lakehead University's Faculty of Forestry. After three years of forests practice, Devon received his Registered Professional Forester status.
In 2012, Devon met Dr. Flannigan and wrote a proposal to research sprinkler efficacy. The research intent is to alleviate drought stress by watering hazardous fuel beds to inhibit combustion. Devon believes sprinklers can meet both protection and ecological objectives around values at risk.

88. The Effectiveness Of Post-fire Rehabilitation At Altering Fire Return Intervals In The Sagebrush Steppe

Presenter: *Bowman-Prideaux, Chris, Graduate Student, Univ of Idaho, Forest, Rangeland, & Fire Sciences*
Additional Author(s):
Newingham, Beth A. Assistant Professor, University of Idaho

Historically, aridlands have had infrequent fire due to patchy plant distributions, which limit fire spread. However, aridland fire regimes have changed because invasive annual grasses have created continuous fuel beds, which have led to increasingly frequent fires and a greater area burned each decade since the 1970s. Climate change is predicted to further increase the number and size of fires. Post-fire rehabilitation is enacted in order to reestablish plant communities and has the potential to further alter fire regimes. Rehabilitation treatments include tilling seeds using a tractor and drill (drill seeding), dropping seed aerially with helicopters (aerial seeding), or both. Few studies examine the impact of post-fire rehabilitation on the likelihood of future fires in these aridland ecosystems. We examined the effects of post-fire rehabilitation treatments on the number of years before the next fire. Using GIS layers detailing fire history and post-fire rehabilitation treatments in the southern Idaho Great Basin, we extracted information from randomly selected sites and analyzed them with generalized linear models. The total number of burns at a site was inversely related to the time before the next fire (P=0.001), but there was no difference in the period between fires after the third fire (P=0.733). Most drill seeding occurred after the first fire, but only 6 sites were drill seeded after the second or third fire at the site. Drill seeding resulted in longer durations between fires than untreated sites when used after the first and third fire, but there was no difference between those treatments after the second fire. Aerial seeding consistently resulted in the shortest fire return interval among treatments, averaging 3 years between fires following the second fire. Across sites and irrespective of the number of fires at a site, the average fire return interval was 17 years at untreated sites, 22.5 years at drill seeded sites, 5 years at aerial seeded sites and 10 years at sites that were treated with both aerial and drill seeding techniques. These data indicate sites with aerial seeding are more prone to fire. Drill seeding sites after a fire appear to promote longer fire return intervals, but a small sample size after more than one fire makes drawing conclusions premature. These results suggest managers should consider drill seeding on sites that experienced multiple fires to help determine whether such post-fire treatment will consistently yield longer post-fire return intervals than untreated sites.

Keywords: Post-fire rehabilitation, sagebrush steppe, drill seeding, aerial seeding, aridlands

Bio: Chris earned his bachelor degree from Occidental College. He earned his Master of Science at California State University, Northridge where he found evidence of differentiation among populations of a rare, disturbance-adapted Astragalus. He is currently working on his Ph.D. at the University of Idaho examining the potential impact of the number of fires on post-fire rehabilitation in the sagebrush steppe.

89. Fuels Dynamics and Potential Fire Behavior after Variable Retention Harvert in Lodgepole Pine

Presenter: *Crotteau, Justin, University of Montana*
Additional Author(s):
Keys, Christopher R., Department of Forest Management, University of Montana,
Wright, David K. , Forest and Woodland Ecosystems Science Program, Rocky Mountain Research Station, USDA Forest Service
Sutherland, Elaine K. , Forest and Woodland Ecosystems Science Program, Rocky Mountain Research Station, USDA Forest Service

Historical management of lodgepole pine forests availed even-aged silvicultural strategies, yet multi-cohort management may mitigate external ecosystem stressors such as wildfire by promoting stand vigor and spatial heterogeneity. In the year 2000, an experimental variable retention harvest at the

Tenderfoot Creek Experimental Forest established two divergent stand structure patterns, treating 16 of 20 stands. Approximately 50% of the overstory trees within each stand were retained in either an aggregated or dispersed arrangement; two replicates from each treatment were subsequently broadcast burned. We quantify and present surface fuel loadings within these stands immediately after treatment and again in 2012, establishing downed woody debris treatment reference conditions. Furthermore, we fit linear mixed-effects models to describe the effects of treatment over time on an array of surface fuel size-class responses. One key finding that models report is a greater debris reduction in treated versus control stands in the all but the 1000-hr fuel class (p-value range: [0.0003, 0.0778]); retention arrangement and burn effects are also reported by fuel size class. Finally, analysis of potential fire behavior suggests more varied fire behavior in both aggregated and dispersed stands than in controls, as per common behavior metrics (e.g., flame length, crowning index). Fire behavior models suggest that control and post-treatment conditions are capable of carrying a crown fire but probability of crown ignition is low. In dense crown conditions common among lodgepole pine stands, we hypothesize that canopy fragmentation within and among stands as created by variable retention harvests may increase stand resilience to wildfire.

Bio: Justin Crotteau is a graduate student at the University of Montana where he studies the effects of forest management on tree growth, natural regeneration, and fuels dynamics under the advising of Dr. Christopher Keyes in the Applied Forest Management Program. He received his MS from Humboldt State University in 2011 studying post-fire natural regeneration trends.

90. Mitigating the potential for large fires—an investigation of fuel treatment alternatives at Army Garrison Camp Williams

Presenter: *Frost, Scott*
Additional Author(s):
Jenkins, Michael, Associate Professor, Disturbance Ecology and Management, Department of Wildland Resources, Utah State University
Alexander, Martin E., Adjunct Professor, Department of Wildland Resources, Utah State University
Ramsey, Douglas, Professor, Director of Remote Sensing and GIS Laboratory, Department of Wildand Resources, Utah State University
Thomas, Dave, Fire Behavior and Fire Safety Consultant, Renoveling LLC

The first step of the research involves mapping the fuel model distribution found at Army Garrison Camp Williams (AGCW) according to the standards developed by Anderson (1982) and Scott and Burgan (2005). Using the vegetation triplet (Keane et al., 2001), which is a combination of biophysical, species composition, and vertical stand structure data, a fuel model layer will be developed. This fuel model layer will then be mapped and validated by fuel plot data collected by personnel at AGCW in 2011. Using RAWS data, a narrative of conditions will be created for weather related to fire behavior prediction. Each day of the weather record will then be used with fuel model classifications to generate predicted flame length, rate of spread, and fireline intensity. The fireline intensity output will then be inserted into an equation developed by Wilson (1988), designed to determine the probability of firebreak breach in grasslands. From this output, probability of firebreak breach will be generated for the timeline of the weather data.
The fuel model layer developed in the first step will then serve as input into spatial fire behavior spread software such as FARSITE (Finney, 1999) and FlamMap (Finney 2006). The performance of different treatment alternatives, combinations, and ignition sources can then be simulated for the fuels, weather,

and topography typically present at AGCW. Using Light and Detection Ranging (LiDAR) data collected in 2011 at Camp Williams, an estimate of gambel oak regeneration rates will be attempted for maintenance schedules.

Keywords: Firebreak, Wildland Urban Interface, Light Detection and Ranging (LiDAR), FARSITE, FlamMap

Bio: I was raised in southeastern Utah canyon country and love the outdoors! From 2009 to 2012 I spent my summers working in wildland fire for the Forest Service, while spending the rest of my time at Utah State University. I received my B.S. in Geography in 2012 and since January of 2013 have been working towards an M.S. in Forestry. My research is a combination of my work experience in wildfire and my geography background in planning, GIS, and remote sensing. I currently work as a Pathways GIS intern for the USGS Water Science in Salt Lake City, UT.

91. A comparison of LANDFIRE fuel representation systems and their application in estimating fire effects across landscapes

Presenter: *Hyde, Josh, Research Instructional Associate, University of Idaho*
Additional Author(s):
Strand, Eva, Assistant Professor, University of Idaho
Hudak, Andrew, Research Forester, USDA Forest Service

Researchers and managers are often tasked with estimating the impacts of wildfire on the landscape. LANDFIRE Fuels Classification Characterization System (FCCS) fuels and Fuel Loading Model (FLM) fuel data layers represent a ready source of information for estimating fire effects. The objective of this study is to document the differences in these fuel data layers, compared to a measured fuels data set and the subsequent impact on fire effects as analyzed by the Wildland Fire Assessment Tool (WFAT) for the example of a mixed conifer forest example.

Results indicated estimated duff loading was likely to be higher in the LANDFIRE FCCS fire effects fuel model (FCCSL), and estimated 1000 hour fuel loading lower in the LANDFIRE FLM Fire effects fuel model (FLML). Shrub loadings were greater in the FLML compared to FCCSL. Spatial distribution differed for FCCSL and FLML, with FCCSL layers appearing as a series of larger polygons, and FLML layers being distributed across the landscape as a series of small polygons. A customized fuel layer is likely to represent a mixed conifer forested landscape more accurately than an unaltered LANDFIRE FCCS or FLM layers.

Keywords: fire effects, planning, Wildland Fire Assessment Tool, WFAT

Bio: Josh Hyde is an Instructional Associate and Program Coordinator for the University of Idaho department of Forest, Rangeland, and Fire Sciences, working remotely from the Pacific Wildland Fire Sciences Laboratory in Seattle WA. He has a BSc in Rangeland Ecology and MSc in Forest Resources from the University of Idaho. Josh works with the NWCG Smoke Committee developing outreach materials on smoke and air quality issues, perform training assessments, and coordinate outreach efforts. Josh also works with the Wildland Fire Research and Development Group reviewing geospatial fuels management tools, and reviewing and developing learning content for these tools.

92. Spatial and temporal variability of forest floor duff moisture: autocorrelation and scales of importance

Presenter: *Kreye, PhD, Jesse, Postdoctoral Research Associate, Mississippi State University*
Additional Author(s):
Varner, Morgan, Assistant Professor, Mississippi State University
Dugaw, Christopher, Associate Professor, Humboldt State University

Smoldering fires in forest floor fuels is poorly understood and consumption patterns often vary even at small spatial scales. The ecological consequences of duff fires have been documented in fire-excluded ecosystems but with little attention to their variability in space. Physical characteristics of duff may influence the ignition and spread of smoldering fires and their spatial patterns on the forest floor may be an important link to the heterogeneity of consumption often observed following prescribed or wild fires. We evaluated important fuel bed-scale characteristics (depths, bulk densities, and moisture contents) of fermentation and humus duff horizons in a long-unburned longleaf pine (Pinus palustris Mill.) forest in northern Florida, USA and quantified their spatial variation up to the forest (103 m) scale. Fermentation and humus horizons similarly varied in depths (ranging from 0 to 14 cm) with moderate to strong spatial autocorrelation occurring at smaller scales in both, however fermentation bulk density varied less than humus bulk density, which varied considerably at fine scales. Fermentation horizons held more moisture than humus following precipitation, but moisture contents varied in this upper horizon, whereas humus remained relatively dry even after heavy rains. Humus moisture contents were moderately autocorrelated at small scales, but fermentation horizons showed no evidence of spatial autocorrelation under dry, intermediate, or wet conditions, highlighting their fine-scale variability. Evidence from this study indicates differential moisture absorption between horizons following rains in a long-unburned longleaf pine forest but also that high fine scale variation occurs in the upper horizons where ignition occurs. Fine-scale variation in these important duff characteristics both vertically and horizontally may contribute to heterogeneous duff consumption patterns often observed following smoldering fires.

Keywords: duff, forest floor, spatial autocorrelation, landscape ecology

Bio: Jesse Kreye is a postdoctoral research associate in the Forest and Wildlife Research Center at Mississippi State University.

93. The relationship between foliar chemistry and heat content of live wildland fuels

Presenter: *Kropp, Rachael, Biological Sciences Technician, USFS, RMRS, Fire, Fuel and Smoke Science Program*
Additional Author(s):
W. Matt Jolly
Elliott T. Conrad

Heat content is an important fuel physio-chemical characteristic that represents the maximum energy that can be released during wildland fire combustion. It is needed by fire behavior models to simulate wildland fires but little is known about the factors that drive both within- and between-species heat content variations. This study seeks to understand these variations by identifying key influential chemical components. Foliar heat content and chemical components on a dry weight basis were

measured and compared in 20 fuel species within fire dependent communities in Florida, Montana, and Wisconsin. Heat content varied between species, ranging from 19.4 to 22.6 MJ/kg. These numbers were most closely correlated with crude fat and non-structural carbohydrate (NSC) content which ranged from 1.4 – 13% and 4.6-33.1%, respectively. A multivariate linear model using crude fat and NSC as independent variables values explained 72% of the total variation in heat content. These results will improve our ability predict intra- and inter-species differences in live fuel fire behavior.

Keywords: Heat Content, Chemistry, fire modeling

Bio: Rachael Kropp graduated from The University of Minnesota, Twin Cities with degree in Environmental Sciences, Policy, and Management, and a minor in Chemistry. She has been working for the Fuel, Fire, and Smoke program for 2 years.

94. The Four Forest Restoration Initiative

Presenter: *Lata, Mary, Fire Ecologist, Four Forest Restoration Initiative (4FRI)*

The Four Forest Restoration Initiative (4FRI) is a collaborative effort to restore forest ecosystems on portions of four national forests - Coconino, Kaibab, Apache-Sitgreaves, and Tonto - along the Mogollon Rim in northern Arizona. Ponderosa pine forest stretches almost continuously from the south rim of the Grand Canyon, across the Mogollon Rim, though the White Mountains in eastern Arizona, and into New Mexico.

These forests have been degraded by unsustainable historical land uses, including fire exclusion. The result is overgrown forests with thin, unhealthy trees and the threat of unnaturally severe wildfire. The vision of 4FRI is restored forest ecosystems that support natural fire regimes, functioning populations of native plants and animals, and forests that pose little threat of destructive wildfire to thriving forest communities, as well as supporting sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values.

Four national forests are actively engaged in a collaborative, landscape-scale initiative designed to accelerate restoration infire-adapted ecosystems in the Southwestern Region. Those forests are the Kaibab, Coconino, Apache-Sitgreaves and Tonto. Together with a diverse group of over 30 individuals and organizations as stakeholders, the four forests are working to collaboratively plan and carry out landscape-scale restoration of ponderosa pine forests in northern Arizona.

In addition to the restoration of ponderosa pine forests, the 4FRI includes restoration of aspen, montane grasslands, pine/oak, springs and seeps, and will implement decisions already made for travel management, such as decommissioning and closing roads. The analysis that is being completed for the first ~1/3 of the project is as extensive as it is complex, recommending treatments (mechanical and/or fire) on almost 600,000 acres. Four action alternatives were analyzed, in addition to a No Action Alternative. At the time of this conference, the Final Environmental Impact Statement is nearly complete.

Bio: Dr. Mary Lata is a Fire Ecologist on the core team for the Four Forest Restoration, working out of Flagstaff, Arizona.

Mary began working in land management with the Iowa Department of Natural Resources in 1991, and has since worked for The National Park Service, The Nature Conservancy, and the US Forest Service. From 2002 - 2010, Mary was the Fire Ecologist for the Nebraska/McKelvie National Forests & Buffalo Gap, Fort Pierre, and Oglala and National Grasslands. Personnel limitations on this small 'forest' meant that she also managed the Fuels, Hydrology, Soils, and Botany programs for several years. She began working for the 4FRI in 2010.

95. Little Bear Fire: Pre-Fire Hazardous Fuel Treatment Effectiveness

Presenter: *McNeill, Rick, Ecologist, New Mexico Forest and Watershed Restoration Institute*
Additional Author(s):
Reid, Kent, Director, New Mexico Forest and Watershed Restoration Institute
Brown, Sara, Assistant Professor, New Mexico Highlands University

The Little Bear Fire ignited from a lightning strike on June 4, 2012, in the Lincoln National Forest in south-central New Mexico. It burned 44,330 acres and 265 structures, making it the most financially destructive fire in New Mexico history. Prior to the fire, various hazardous fuel reduction treatments were implemented on private, city and federally managed land: thinning; thinning and piling; thinning and mastication; and thinning, mastication and removing the masticated materials. The relative effectiveness of these treatments is not well understood; this study evaluates these treatments based on fire severity (as classified by the U.S. Forest Service), tree mortality, and bare ground. We sampled across 47 plots using the Line Point Intercept protocol to measure ground cover, and 1/10 acre circular plots to measure tree mortality, trees/acre, basal area, and species. A principle component analysis was conducted using SPSS to evaluate relationships. Our findings determined that thinning, mastication and removing masticated materials resulted in the lowest mean fire severity, and lowest tree mortality compared to the other treatments, and a lower percentage of bare ground compared to the thin and pile treatment; while thin and pile resulted in the highest mean fire severity and highest tree mortality compared to the other treatments.

Keywords: Little Bear Fire, Hazardous fuel treatment, New Mexico

Bio: Richard McNeill is a graduate of the Ecology and Conservation Biology program at the University of Idaho. He has worked as a botanist/ecologist in every state from the continental divide, west to the Pacific Ocean. His passions include rock climbing, slot canyons and biogeography.

96. Spruce beetle legacies on fuel loads in the southern Rocky Mountains, CO.

Presenter: *Mietkiewicz, Nathan, PhD Student, Clark University*
Additional Author(s):
Kulakowski, Dominik, Professor of Geography, Clark University

Recent outbreaks of spruce beetle (Dendroctonus rufipennis) have killed over 400,000 ha of subalpine forests in the southern Rocky Mountains between 1998 and 2011 (USDA Region 2 ADS data) and are believed by many land managers to become the next catastrophic disturbance to affect Colorado's landscape, yet this has received relatively little research attention compared to the outbreak of mountain pine beetle. Outbreaks of bark beetles often lead to concern among the public and policy makers regarding perceived increases in fire risk, though recent studies have stressed that the effect of

outbreaks on fires are complex and sometimes counterintuitive. Missing from our current understanding is how pre-outbreak forest conditions mediate the effects of outbreaks. To study how these complex interactions affect fuel load abundances in spruce beetle attacked stands we collected fuels data across a chronosequence of post-outbreak sites, stratified by young (<130 yrs) and old (>130 yrs) stands. Canopy and surface fuel loads were calculated for each tree and stand, and available crown fuel load, crown bulk density, and canopy bulk densities were estimated. Here we present these results and discuss how pre-outbreak conditions mediate the effects of spruce beetle outbreaks on fuels. Our results suggest that the effects of outbreaks on fire risk are highly contingent on pre-outbreak stand structure, which is largely shaped by long-term disturbance history.

Keywords: Wildland fire, fuels, spruce beetles, disturbance ecology

Bio: Nathan Mietkiewicz earned a B.S. in Earth System Science at the University of Maine, Orono, an M.S. in Geographic Information Science for Development and the Environment at Clark University, and is currently pursuing a PhD in Geography at Clark University. Nathan's current research interests lie at the intersection of climate change, forest/disturbance ecology, and remote sensing. To that end, he is examining the legacies of spruce beetles on the abundance of forest fuels in order to understand fire risk in the southern Rocky Mountains under a varying climate.

97. Enhanced Canopy Fuel Mapping through Integration of Lidar Data

Presenter: *Peterson, Birgit, Scientist, ASRC Federal InuTeq, Contractor to USGS EROS*
Additional Author(s):
Nelson, Kurtis, Physical Scientist, USGS EROS

The Fire Science Team at the US Geological Survey's Earth Resources Observation and Science center has long been engaged in developing information products regarding vegetation type, vegetation structure, and fuel for wildland areas, primarily through the LANDFIRE program. These products were generated using source data including field observations and Landsat imagery. The LANDFIRE products have received wide use for a variety of applications. A primary aim of the Fire Science Team is to keep these data current and relevant to users. In part, this is accomplished through periodic updating or remapping. However, the LANDFIRE program also recognizes that the incorporation of new data from different sources may also enhance the current LANDFIRE product suite. To this end, the Fire Science Team is exploring the use of new remote sensing data for mapping vegetation structure and fuel characteristics relevant to fire behavior modeling. Specifically, the team is examining how lidar data can be integrated into the LANDFIRE mapping methods. Lidar is of particular interest to the team because of its ability to collect data in three dimensions, a capability that makes it uniquely suitable for gathering data on vegetation structure and the arrangement of fuel data, especially in forest canopies. The Fire Science Team has several completed and ongoing studies focused on integrating lidar into the LANDFIRE mapping that illustrate the different ways in which lidar can be used to enhance the mapping process. For example, a 2013 remapping of forest canopy height for Alaska included lidar waveform data from the Geoscience Laser Altimeter System that provided global samples of vegetation structure. The Creating Hybrid Structure from LANDFIRE/lidar Combinations application was also developed to promote the use of available lidar data and enable the easy derivation of structure and fuel maps to be used with existing LANDFIRE maps to model fire behavior. There are several challenges to incorporating lidar into a national mapping effort. There is currently no lidar dataset that covers the nation wall-to-wall. Furthermore, the disparate lidar datasets that do exist are collected with differing specifications

for different purposes. Even single lidar data collections can be large in volume, making data storage and handling challenging. To address these challenges the Fire Science Team will next look at available lidar datasets, the results of previously conducted projects, and the mandates for LANDFIRE in the future to develop a cohesive approach for integrating lidar data into future mapping efforts.

Keywords: wirldland fuel, canopy, lidar, remote sensing

Bio: Dr. Peterson is a contractor at the USGS Earth Resources Observation and Science Center in Sioux Falls, SD. There she has worked as part of the Fire Science Team since 2005. Her research focuses on the integration of lidar into vegetation structure and fuel mapping.

98. Predicting Smoke: Spatial Analysis of Fuel Loadings at the National Level

Presenter: *Silverstein, Robin, Ecologist, College of Forestry and Conservation, University of Montana*
Additional Author(s):
Urbanski, Shawn P., Research Chemist, Fire Sciences Laboratory, US Forest Service Rocky Mountain Research Station
Reeves, Matt C., Research Ecologist, Forestry Sciences Laboratory, US Forest Service Rocky Mountain Research Station
Hao, Wei Min, Supervisory Research Chemist, Fire Sciences Laboratory, US Forest Service Rocky Mountain Research Station

Estimating smoke emissions at large spatial scales requires an estimation of existing fuel. We developed a map for the contiguous United States that will be used to estimate fuel loadings. The map divides the landscape into five classes: 1) forest type group (FTG) based on the US Forest Service Remote Sensing Applications Center (RSAC) / Forest Inventory Analysis (FIA) map, 2) rangeland biomass, 3) LANDFIRE Existing Vegetation Type (EVT), 4) Average Biomass from EVT and LANDFIRE Existing Vegetation Cover Percent (EVC), and 5) EVT to FIA forest type. Fuel loadings will be based on biomass estimates from FIA plot data for the FIA forest and modeling of rangeland biomass. Fuel loading for forests is taken from a new forest fuel classification which was developed from a large set of USFS Forest Inventory and Analysis surface fuel estimates. Rangeland fuel loading is estimated with a Normalized Differenced Vegetation Index (NDVI) based biomass product developed using a large set of field data from the USDA Soil Survey Geographic (SSURGO) database, NDVI from the MODIS sensor on the Terra satellite, and landscape attributes (Reeves, 2013). The fuel loading map will be used in conjunction with burn severity mapping from large fires to enable estimates of smoke emissions and impacts.

Keywords: Wildland fuels, smoke, biomass, GIS
Bio: Robin Silverstein is an ecologist working for the College of Forestry and Conservation, University of Montana, as a cooperator with the Fire, Fuels, and Smoke Science Program of the Forest Service's Missoula Fire Sciences Lab. His background includes a Masters in ecology from San Diego State University and a Master of Public Health from the University of Montana, Missoula. He has over ten years' experience working at the Rocky Mountain Research Station, primarily performing spatial analysis on fire-related topics.

99. EVALUATING FUEL TREATMENT EFFECTS ON THE SPATIAL SCALE OF SURFACE FUELS IN FRONT RANGE PONDEROSA FORESTS

Presenter: *Vakili, Emma, Graduate Research Assistant, Colorado State University*
Additional Author(s):
Hoffman, Chad, Assistant Professor, Colorado State University
Keane, Robert, Research Ecologist, U.S. Forest Service
Dickinson, Yvette, Assistant Professor, Colorado State University
Rocca, Monique, Associate Professor, Colorado State University

Recent research has shown the important influence of fuel variability on wildfire behavior and effects. This has resulted in a need for more accurate quantification of fuels across spatial scales, including a description of variability. However, few studies to date have assessed the spatial variability of wildland fuels or investigated the inherent scales at which they vary, especially after fuels treatments. This study investigates the characteristic length scale and spatial variability of surface fuelbed components in dry ponderosa pine forests on the front range of the southern Rocky Mountains pre- and post-fuel reduction treatment. Preliminary results suggest that the overall variance of surface fuel component loading tends to increase while the characteristic length scale or patch size decreases with treatment, but that this effect is reduced when the treated stand has also been burned. The results from this study will contribute to the development of the next generation of fuel models and the creation of more accurate and efficient sampling techniques to help land managers assess the effects of their treatments on fuelbeds.

Keywords: Wildland Fuels, Fuel Treatment, Southern Rockies, Heterogeneity

Bio: Emma Vakili is a Masters candidate and Research Assistant at Colorado State University in the Department of Forest and Rangeland Stewardship. She received a B.S. in Mathematics and a B.A. in Political Science from Indiana University. Her current research focuses on quantifying the variability of wildland surface fuels in dry Ponderosa forests.

100. The natural trade-offs of reducing chaparral fire risk

Presenter: *Wilkin, Kate, PhD Candidate, University of Californiat at Berkeley, Dept. of Environmental Science, Policy, and Management*
Additional Author(s):
Stephens, Scott, Professor, University of California at Berkeley
Potts, Jennifer, Resource Ecologist, Audubon Canyon Ranch
Fry, Danny, Research associate, University of California at Berkeley
Newman, Erica, Phd Candidate, University of California at Berkeley
Tubbesing, Carmen, Technician, Phd Candidate, University of California at Berkeley

Large wildfires are common throughout California's chaparral where many people live. This has contributed to a large loss of human life and infrastructure. Due to the escalating wildfire losses and suppression costs, wildfire risk reduction is a priority for California's Wildland Urban Interface (WUI). Fuel reduction treatments, such as prescribed fire and mastication, are widely applied to reduce fire risk. These treatments help protect homes and communities from fire yet facilitate the invasion of non-

native species in the short-term. In the long-term, the ecological trajectory and fire risk of these treatments is poorly understood.

To address these research gaps, we evaluate 10+ years of ecological and fire risk changes caused by fuel reduction treatments (fire/mastication) with a seasonal effect (fall/winter/spring) including a control in California. We focus on three main questions: (1) Which fuel reduction treatment best reduces fire risk? The probability of fire will be assessed by site flammability or herbaceous cover, especially nonnative annual grass. The probability of a catastrophic fire will be evaluated with estimates of total fuel biomass in addition to shrub height, cover, and continuity. (2) Which fuel reduction treatment minimizes nonnative species invasion and persistence? We will evaluate nonnative species richness, abundance, and cover. (3) What are other ecological effects of fuel reduction treatment? We will evaluate shrub cover, composition, and structure in coordination with wood rat midden presence.

Keywords: California, chaparral, fuel treatments, prescribed fire, mastication, ten-year remeasure

Bio: Kate was first mesmerized by ecological processes in Florida, the lightning strike capital of the US, where she witnessed yearly floods and fire which catalyze native biodiversity and ecosystem health. Here she spent innumerable hours botanizing. As she studied the vegetation, she began to understand the post-fire patterns in relationship to hydrology, past land use, and connectivity. Kate's intrigues in plants' response to fire lead to Master's research on chaparral's resilience to fire (Wilkin et al., Mimicking Fire to Improve Chaparral Restoration, Madrono, July 2013). Today Kate continues to research and bushwhack through chaparral as UC Berkeley PhD Candidate who researches the trade-offs of reducing fire risk.

101. Sustainable Biomass Supply from Forest Health and Fire Hazard Reduction Treatments: A Biomass Assessment of Federally Owned Land in Eastern Oregon

Presenter: *Vogler, Kevin*
Additional Author(s):
Bailey, John, Associate Professor, Oregon State University

In order to alter the current annual trend of an ever increasing number of uncharacteristically large and high severity wildfires, a proactive fuels management strategy that produces significant results, at meaningful scales, must be undertaken by the federal land agencies. One challenge that hinders the development of large forest restoration programs, is the relatively low value of material generated from fuel reduction treatments. There is currently opportunities to utilize that low value material in newly emerging biomass and non-traditional forest product markets where the scale of development can be appropriately matched with current and future biomass feedstock supply. My research quantifies the availability of biomass feedstock generated from landscape level restoration treatments in Eastern Oregon using a model framework that integrates FIA forest data with the ArcFuels and Landscape Treatment Designer model tools. A model sensitivity analysis was conducted on a range of silvicultural prescriptions and management intensity levels in in order to understand the relationship between feedstock generation and fire hazard reduction.

Keywords: Biomass, FVS, ArcFuels, Fire Hazard

Bio: Kevin Vogler is a graduate student working towards his Master of Science in silvilculture at Oregon State University. He completed his undergraduate education at State University of New York College at Oneonta where he received a bachelor's degree in environmental science and environmental biology.