

Restoring the West 2015

Restoration and Fire in the Interior West



October 28 & 29, 2015
Utah State University
Logan, Utah
www.restoringthewest.org

2015 Restoring the West Conference

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Darren McAvoy, USU Forestry Extension Associate

Mike Kuhns, USU Professor, Wildland Resources Department Head & Forestry Extension Specialist

Mark Brunson, USU Professor, Environment & Society Department

Eric LaMalfa, USU Graduate Research Fellow

Brad Washa, Utah Bureau of Land Management State Fuels Specialist

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Agenda

Wednesday, October 28, 2015

USU Eccles Conference Center

7:30 - 9:00 a.m.	Registration Open
8:30 - 8:35 a.m.	Welcome , Dean Chris Luecke, Quinney College of Natural Resources, Utah State University, Logan, Utah
8:35 - 8:40 a.m.	Conference Overview , Darren McAvoy, Forestry Extension Associate, Utah State University, Logan, Utah
8:40 - 9:20 a.m.	Pinyon and Juniper Woodlands in the Intermountain West: Fire Ecology, Resilience, and Resistance Across Heterogeneous Landscapes , Rick Miller, Professor Emeritus of Range and Fire Ecology, Department of Range Ecology and Management, Oregon State University, Corvallis, Oregon
9:20 - 10:00 a.m.	Are Recent Large and Severe Fires Really Extraordinary? How Long-Term Records of Fire Can Inform Fire Ecology and Management in the Western U.S. , Jen Pierce, Associate Professor, Department of Geosciences, Boise State University, Boise, Idaho
10:00 - 10:30 a.m.	Break
10:30 - 11:00 a.m.	Prioritizing and Implementing Treatments to Address Wildfires and Invasive Annual Grasses in Sage-Grouse Habitat , Mike Pellant, Senior Ecologist, National Office, Bureau of Land Management, Boise, Idaho
11:00 - 11:30 a.m.	Fire and Collaboration on the Fishlake National Forest , Jason Kling, Richfield District Ranger, Fishlake National Forest, Richfield, Utah
11:30 - 12:00 p.m.	The Monroe Mountain Working Group: Benefits and Challenges of Collaboration , Bill Hopkin, Grazing Specialist, Utah Department of Agriculture and Food, Salt Lake City, Utah
12:00 - 1:30 p.m.	Poster Session and Lunch
1:30 - 2:00 p.m.	The Role of Fire and Fire Surrogate Treatments in Restoring Sagebrush Habitat in Utah's West Desert , Brad Jessop, Range Ecologist, West Desert District, Bureau of Land Management, West Valley City, Utah
2:00 - 2:30 p.m.	Tracking Post-Wildfire States and Transitions in the Sagebrush-Steppe , G. Matt Davies, Assistant Professor, School of Environment and Natural Resources, The Ohio State University, Columbus, Ohio
2:30 - 3:00 p.m.	The Watershed Restoration Initiative and Fire , Alan Clark, Watershed Program Director, Utah Department of Natural Resources, Salt Lake City, Utah
3:00 - 3:30 p.m.	Break
3:30 - 4:00 p.m.	Understanding the Effects of the Twitchell Canyon Wildfire on Stream Geomorphology and Fish Habitat , Patrick Belmont, Assistant Professor, Department of Watershed Sciences, Utah State University, Logan, Utah
4:00 - 4:30 p.m.	Designing a Regional Network of Fuel Breaks to Protect Greater Sage-Grouse Habitat: An Experimental Approach using Circuitscape , Nathan Welch, GIS Analyst, The Nature Conservancy Boise Office, Boise, Idaho
4:30 - 5:00 p.m.	Monitoring the Impact of Climate Change on Fire Frequency and Severity in Great Basin Bristlecone Pine Sky Island Ecosystems , Mike Jenkins, Associate Professor, Department of Wildland Resources, Utah State University, Logan, Utah
5:30 - 7:30 p.m.	Reception at Cafe Sabor, 600 W Center St. Shuttle leaves from USU University Inn every 15-20 minutes, starting at 5:15

Thursday, October 29, 2015
USU Eccles Conference Center

8:00 a.m.	Registration Open
8:30 - 8:35 a.m.	Welcome , Mark Brunson, Professor, Department of Environment and Society, Utah State University, Logan, Utah
8:35 - 9:15 a.m.	Restoring Whitebark Pine (<i>Pinus albicaulis</i>) Ecosystems of the West in the Face of Climate Change , Robert Keane, Research Ecologist, Rocky Mountain Research Station, USDA Forest Service, Missoula, Montana
9:15 - 9:55 a.m.	Tree-Ring Reconstructions of Fire and Forest Histories: Providing the “What” and “Why” for Forest Restoration , Peter M. Brown, Director, Rocky Mountain Tree-Ring Research, Fort Collins, Colorado
9:55 - 10:15 a.m.	Break
10:15 - 10:45 a.m.	Of Fire, Sage Grouse and Our Federal Lands , John Freemuth, Professor, School of Public Service, Boise State University, Boise, Idaho
10:45 a.m. - 11:15 a.m.	Past and Future Wildfire in the Interior West as Predicted by the Calibrated Combustion Dynamics of Ecosystems , Richard Guyette, Associate Research Professor, School of Natural Resources, University of Missouri, Columbia, Missouri
11:15 a.m. - 12:00 p.m. Up and coming research from graduate student scientists	Bringing Back the Trout: Metapopulation Viability of Bonneville Cutthroat Trout in a Fire-Impacted Watershed , Colton Finch, PhD Candidate, Department of Watershed Sciences and Ecology Center, Utah State University, Logan, Utah Post-Fire Grazing Management of Sagebrush Steppe Plant Communities in the Great Basin , Jeffrey Gicklhorn, Research Assistant, University of Nevada Reno, Reno, Nevada Unraveling Fire and Herbivore Interactions to Manage Tree Cover in an African Savanna , Eric LaMalfa, PhD Candidate, Wildland Resources Department, Utah State University, Logan, Utah
12:00 p.m. - 1:00 p.m.	Lunch
1:00 p.m. - 1:30 p.m.	Public and Agency Perceptions of Smoke from Wild and Prescribed Fire , Christine Olsen, Research Social Scientist, Department of Forest Ecosystems and Society, Oregon State University, Corvallis, Oregon
1:30 - 2:00 p.m.	The Role of Prescribed Fire Councils in Restoring the West , J. Morgan Varner, Department of Forest Resources & Environmental Conservation, Virginia Tech, Blacksburg, Virginia
2:00 - 2:30 p.m.	Use of Livestock to Mitigate Risk of Wildfire , Troy Forrest, Program Manager/NW Region Coordinator, Utah Grazing Improvement Program, Utah Department of Agriculture and Food, Salt Lake City, Utah
2:30 to 3:00 p.m.	Fire, Rain, and Post-Fire Restoration of Sagebrush Steppe in the Great Basin , David S. Pilliod, Supervisory Research Ecologist, Forest and Rangeland Ecosystem Science Center, US Geological Survey, Boise, Idaho
3:00 to 3:15 p.m.	Break
3:15 to 3:45 p.m.	Insights into Fire Severity and Post-Fire Recovery from an Integrated Analysis of Forestry Inventory Data and Long-Term Fire Mapping Datasets , Sara Goeking, Biological Scientist, Forest Service, Rocky Mountain Research Station, Inventory and Monitoring Program
3:45 to 4:15 p.m.	Quaking Aspen: a Burning Desire in an ‘Asbestos Forest’ , Paul Rogers, Director, Western Aspen Alliance, Adjunct Associate Professor, Utah State University, Logan, Utah

Speaker Abstracts

In order of presentation

Pinyon and Juniper Woodlands in the Intermountain West: Fire Ecology, Resilience, and Resistance Across Heterogeneous Landscapes

Rick Miller, Professor Emeritus of Range and Fire Ecology, Department of Range Ecology and Management, Oregon State University, Corvallis, Oregon

Pinyon and juniper woodlands occupy more than 70 million acres in the Intermountain Region of the American West. They grow at elevations ranging from <2,000 to >8,000 ft and are typically found in precipitation zones between 10 to 20 inches. Seasonal distribution of precipitation significantly varies regionally with <10 to >35% received as summer precipitation. Disturbance regimes and the dynamics between sagebrush-steppe and sagebrush shrub particularly as they relate to fire and drought also significantly vary both at regional and local scales. The high degree of heterogeneity across these woodlands makes interpreting or predicting vegetation response to disturbance or vegetation management a challenge. In this presentation we will briefly look at woodland ecology and history and then address these key questions: 1) To what degree can we generalize about the history (e.g. expansion and infill), ecology, and management of these woodlands? 2) And, can we use the concepts of resilience and resistance to sort out the heterogeneity and better predict outcomes following wildfire or vegetation management at local and regional scales?

Rick Miller, Department of Range Ecology and Management, Oregon State University, Corvallis, Oregon 97331, phone: (541) 737-1622, email: richardmiller@oregonstate.edu

Rick is Professor Emeritus from Oregon State University. He has worked in plant and fire ecology of sagebrush and juniper woodland ecosystems in the Intermountain Region for nearly 4 decades, primarily out of the Northeastern Oregon Great Basin Experimental Range. His work included; a) determining key factors that influence plant succession, resilience and resistance to invasives as they relate to fire and other disturbances; b) evaluating the impacts of disturbance on the composition and structure on wildlife habitat; c) and developing fire histories that have occurred across these landscapes for the past several centuries. He has authored over 100 refereed scientific publications, several book chapters, and field guides. He retired in 2010 from Oregon State University but continues to work for the Great Basin Science Delivery Program and Joint Fire Science conducting field workshops, summarizing the state of our knowledge on topics related to fire in the Intermountain West, and field guides to help support and direct management decisions.

Are Recent Large and Severe Fires Really Extraordinary? How Long-Term Records of Fire can Inform Fire Ecology and Management in the Western US.

Jen Pierce, Associate Professor, Department of Geosciences, Boise State University, Boise, Idaho
Collaborators: Grant Meyere, Erica Bigio, Nathan Nelson, Mike Poulos, Sara Jenkins, Kerrie Weppner, Kerry Riley, Erin Fitch, Jed Frechette

We examine records of Holocene fires and erosional response recorded in alluvial fan sediments from Idaho and the Northern Rockies, and the southwestern US. This study uses a compilation of nine individual studies, >480 radiocarbon-dated fragments of charcoal, and thousands of individual deposits extending back to ~14 ka. Radiocarbon ages from single charcoal fragments provide evidence of individual fire events across several study

sites; and when combined, these records show minima and maxima in fire activity throughout the Holocene for the western U.S. Our record is of fire-related sedimentation primarily from moderate- to high-severity fires; in the SW especially, recurrence intervals for fire related events (often 100s of years) are much longer than mean fire intervals 10s of years from tree rings. Characteristics of the alluvial deposits, e.g. deposit thickness, and debris flows vs. sheetfloods provide a measure of the geomorphic response to fire and an indication of fire severity and landscape response. Fire chronologies are from three general ecosystems: high elevation mixed conifer forests in the Northern Rockies, montane ponderosa and Douglas-fir forests in the Northern Rockies and Southwest, and low elevation sagebrush steppe and open piñon-juniper woodlands near the Snake River Plain. The combined studies yield the following results. 1) Climate variability drives ponderosa pine and Douglas-fir forests in both the Southwest and Northern Rocky Mountains to burn 'at both ends of the spectrum', where frequent low-severity fires are typical, but higher-severity fires burn during severe droughts following fuel buildup over wet decades. 2) Deposit types vary with ecosystem type; sheetfloods are more common in sparsely vegetated sites and over drier Holocene periods that produce open forests, whereas denser forests and/or infrequent severe fires often produce debris flows. 3) The late Holocene arrival of ponderosa, lodgepole and piñon pine at sites in the Northern Rockies temporally corresponds with an increase in fire activity, suggesting a link between vegetation and fire regime changes. 4) Fires in dry sage steppe ecosystems are generally fuel-limited, but burn during times of multi-decadal to centennial wet and variable climates; grazing and other post-Euroamerican land-use changes, as well as invasive species, particularly influence modern fire regimes at these sites. 5) At moist high-elevation lodgepole pine and mixed conifer sites in Yellowstone and central Idaho, episodic large fire-related debris flows suggest high severity burns, often during times of severe multidecadal drought. 6) While records reveal regionally coherent peaks (e.g. ~200, 500, 900, 1700 and 2600 cal yr BP), historic fire activity is not generally synchronous among sites. Regional differences in climate between the xeric northwestern, northern Rocky Mountain, and monsoonal southwestern sites may account for some of these asynchronies. 7) Recent, severe fires (~1985-2015) have burned in 8 of the 10 sites described; erosional response appears particularly anomalous in the Southwest, where the impacts of Euroamerican fire suppression and land use have been greatest. This begs the question of whether or not widespread and severe modern fires herald the arrival of a new, no-analog era of fire in the western US.

Jen Pierce, Department of Geosciences, Boise State University, Boise, ID 83702, phone: (208) 426-5380, email: jenpierce@boisestate.edu

Jen Pierce researches Quaternary geomorphology, Holocene fire history and climate change, recent fire history and climate change, feedbacks among hydrologic, biologic and geologic systems at Boise State University.

Prioritizing and Implementing Treatments to Address Wildfires and Invasive Annual Grasses in Sage-Grouse Habitat

Mike Pellant, Senior Ecologist, National Office, Bureau of Land Management, Boise, Idaho

Maintaining or restoring Greater Sage-Grouse (sage-grouse) habitat is a high priority for federal land management agencies in the Great Basin. The Bureau of Land Management and Forest Service, with the help of many other entities, developed a tool (Fire and Invasive Assessment Tool (FIAT)) to assist managers in identifying higher priority habitats within selected sage-grouse Priority Areas of Concern (PACs) and the management strategies needed to conserve or restore habitat. Specifically, this assessment assists managers in reducing the threats to Greater Sage-Grouse resulting from impacts of invasive annual grasses, wildfires, and conifer expansion. The cornerstone of the FIAT protocol is recent scientific research on resistance and resilience of Great Basin ecosystems combined with landscape cover of sagebrush. By assessing the resistance to invasive

annual grasses and resilience after disturbance managers are better able to prioritize sage-grouse habitats for conservation and restoration. Once the prioritization process is completed, spatially explicit management strategies are identified and prioritized. Management strategies are types of actions or treatments that managers typically implement to resolve resource issues. They can be divided into proactive approaches (e.g., fuels management and habitat recovery/restoration) and reactive approaches (e.g., fire operations and post-fire rehabilitation). Implementing scientifically sound and effective management strategies are critical for success. The Joint Fire Science Program's Great Basin Fire Science Exchange and SageSTEP projects are two programs that have advanced the science and science delivery needed by managers to meet the challenge of managing or restoring sagebrush steppe habitat. Finally, the recent Department of Interior Secretarial Order 3336 (Rangeland Fire Prevention, Management, and Restoration) and associated implementation plan provides a blueprint to further advance an "all hands, all lands" approach to sagebrush habitat loss in the Great Basin.

Mike Pellant, National Office, Bureau of Land Management, Boise, ID, email: mike_pellant@blm.gov

Mike Pellant is a rehired annuitant for the BLM National Office focusing on Sage-grouse habitat assessments and restoration and serving on the steering committees for the JFS's Great Basin Fire Science Exchange. Prior to retiring from BLM full-time in December 2013, he was the Coordinator for the BLM's Great Basin Restoration Initiative. He has been active in native plant restoration and fire resistant vegetation development as the former project lead for the BLM's Intermountain Greenstripping and Restoration project and the Great Basin Native Plant Project. His career with BLM started in 1976 with the completion of B.S. and M.S. degrees in Range Science at Fort Hays State University in western Kansas. During his nearly 40 year career with BLM he has also specialized in post-fire rehabilitation, range management, and the assessment and monitoring of land health.

Fire and Collaboration on the Fishlake National Forest

Jason Kling, Richfield District Ranger, Fishlake National Forest, Richfield, Utah

The Richfield Ranger District (District) has been working collaboratively with the Monroe Mountain Working Group (MMWG) (20 plus stakeholders) to develop strategies to improve aspen ecosystems on Monroe Mountain; part of which includes reintroducing fire to these disturbance dependent ecosystems. Using fire at a landscape scale (approximately 61,000 acres) to improve and maintain aspen ecosystems over time while also minimizing impacts to private property and other uses on Monroe Mountain has been a challenging task. The Monroe Mountain area, located in Central Utah, encompasses approximately 176,000 acres of National Forest lands and approximately 12,000 acres of private inholdings. Dominant vegetation includes aspen and conifer in the higher elevations and sagebrush and pinyon/juniper in the lower elevations. Monroe Mountain provides elk and mule deer habitat with associated hunting opportunities, multiple allotments for livestock grazing, boreal toad and Bonneville cutthroat trout habitat, Northern goshawk and Flammulated owl habitat, Inventoried Roadless Areas, and much more. In August 2015, the District released a Final Environmental Impact Statement and Draft Record of Decision (ROD) that outlines a 10 year plan to improve aspen ecosystems on Monroe Mountain; a Final ROD is currently being prepared. This four year collaboration process has been enlightening and a success on the Fishlake National Forest, Richfield Ranger District.

Jason Kling, Richfield District Ranger, Fishlake National Forest, 115 East 900 North, Richfield, Utah 84701, phone: 435-896-9233, email: jkling@fs.fed.us

Jason graduated from Utah State University with a Bachelor of Science degree in Fisheries and Wildlife. Following graduation, Jason spent time as the Zone Fish Biologist for the Carson City and Bridgeport Ranger Districts and the Assistant Forest Fish Biologist for the Humboldt-Toiyabe National Forest. In 2010 he accepted

the position of Richfield District Ranger on the Fishlake National Forest where he has been focusing much of his time on improving aspen ecosystems on Monroe Mountain. Jason is married and has 5 children ranging from thirteen to six. His hobbies include spending time with his family, camping, hiking, backpacking, fishing, hunting, etc.

The Monroe Mountain Working Group: Benefits and Challenges of Collaboration

Bill Hopkin, Grazing Specialist, Utah Department of Agriculture and Food, Salt Lake City, Utah

In August of 2015, the Richfield Ranger District of the USFS released a 'Final Environmental Impacts Statement and Draft Record of Decision' for a 10 year plan to improve aspen ecosystems on Monroe Mountain. This was the culmination of a 4 year collaborative effort. This presentation discusses how a group of more than 20 stakeholders arrived at consensus on management changes and restoration projects aimed at improving aspen ecosystem health on Monroe Mountain.

Bill Hopkin, Utah Department of Agriculture and Food, 350 N Redwood Road, PO Box 146500, Salt Lake City, UT 84114, phone: (801) 538-7100, email: bhopkin@utah.gov

Ranch raised in northern Utah, Bill spent the summers managing cattle on family owned private summer range. Intrigued with the relationship between livestock grazing, wildlife populations, resource health, and profitability, he experimented with different rangeland grazing strategies. In 1983 Bill was hired by Gregg Simonds, an outstanding mentor, as Cattle Manager of the 205,000 acre Deseret Land & Livestock Ranch (DLL). He became the General Manager from 1991 to 2004. DLL is well known as a sustainably profitable ranch receiving State and National awards. From 2004-2006, Bill was the General Manager of Deseret Ranches of Florida, Triangle Ranches of Texas, and Sooner Land & Livestock in Oklahoma. From 2006-2013, Bill was the director of the Utah Grazing Improvement Program. Bill and staff worked with Utah ranchers/permittees to invest over \$20 million in projects to improve grazing management on nearly 2 million acres of private and public rangelands. 2013 to present, Bill has worked part time as a Grazing Specialist for the Utah Department of Agriculture and Food and provided consulting services for private ranches in Wyoming and Utah.

The Role of Fire and Fire Surrogate Treatments in Restoring Sagebrush Habitat in Utah's West Desert.

Brad Jessop, Range Ecologist, West Desert District, Bureau of Land Management, West Valley City, Utah

Key to restoring sagebrush habitat in the Great Basin is minimizing wildfire and promoting ecosystem resiliency. Land managers use methods such as fuel reduction treatments and creation of fuel breaks to decrease fire risk and promote perennial dominated landscapes. Mastication (mechanical shredding) of pinyon and juniper has become an important tool for restoring sagebrush habitat throughout Utah's West Desert. Benefits of mastication include ease of implementation, shrub retention, erosion control, and providing safe sites for seed germination and establishment. Achieving the goal of restoring ecological resiliency requires increasing perennial grass and forb cover. Ironically, this increase in fine fuels combined with masticated debris can actually increase the flammability of a site. When fire does occur within masticated treatments, however, fire behavior is modified and intensity is often decreased relative to adjacent untreated sites. Over time, the masticated debris will eventually break down. But in the short term, in some especially fire prone areas, prescribed burning of shredded material is an option to remove the fuel load while keeping the sagebrush component intact.

Brad Jessop, Fuels Natural Resource Specialist, Bureau of Land Management, West Desert District, 2370 S. Decker Lake Blvd., West Valley City, UT 84119

Brad Jessop is a Natural Resource Specialist for the Bureau of Land Management's West Desert District Fuels

Programs. His focus is designing and implementing vegetation treatments that reduce hazardous fuels, promote ecosystem resilience, and restore sagebrush habitat. Brad has been with the BLM since 2008. Prior to working for the BLM, Brad was a Research Associate in the Plant and Wildlife Sciences Department at Brigham Young University where he managed the SageSTEP woodland research sites in Utah. SageSTEP is a regional experiment evaluating methods of sagebrush steppe restoration in the Great Basin. Brad attended BYU where he received a BS in Conservation Biology and MS in Wildlife and Range Resources.

Tracking Post-Wildfire States and Transitions in the Sagebrush-Steppe

G. Matt Davies, Assistant Professor, School of Environment and Natural Resources, The Ohio State University, Columbus, Ohio

Collaborators: Bakker J., Dettweiler-Robinson E., & Dunwiddie P.

The Arid Lands Ecology Reserve of the Hanford Reach National Monument formerly contained one of the last major expanses of Wyoming big sagebrush-dominated habitat in the mid-Columbia Basin. However, increasing wildfire frequency and extent, in response to growing numbers of anthropogenic ignitions and changes in fuel structure caused by cheatgrass invasion have caused successive and noticeable reductions in sagebrush cover. To fully evaluate the effects of repeated disturbances and to prioritize and evaluate restoration activities, managers need to understand how entire vegetation communities change over time. Despite this, changes to the structure of vegetation communities as a whole are difficult to visualise and often rely on analytically-intensive multivariate statistical methods. In contrast state and transition models are easy to use but may lack general applicability and only describe qualitative changes in plant communities. We are developing a simple quantitative method to track changes in sagebrush-steppe vegetation community structure. The model has two axes, one relating to shrub dominance and the other to dominance by native species. This model can be used to track transitions following wildfires and restoration treatments and can also be used to assess the resistance and resilience of communities in relation to disturbance and dominant plant traits. We hope the method will be useful for managers wanting a cost-effective method to evaluate the effects of their management actions in shrub-steppe ecosystems.

Matt Davies, School of Environment and Natural Resources, The Ohio State University, 210 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210, email: davies.411@osu.edu

Originally from Wales, Matt gained a BSc in Environmental Archaeology from the University of Wales Lampeter before moving to Edinburgh for his MSc in Environmental Protection and Management and PhD in fire ecology. For his doctoral and post-doctoral work Matt studied the behaviour and ecological effects of fires in Scottish heather moorlands and contributed to developing a fire danger rating system for the U.K. He worked on a post-doc at The University of Washington supervised by Jon Bakker where he looked at long-term dynamics in sagebrush ecosystems in response to repeated wildfires. Matt is currently Assistant Professor of Soil and Plant Community restoration at The Ohio State University and, with Jon Bakker, has recently secured JFSP funding to continue their work in sagebrush ecosystems. His key research interests are in the use of fire as a management and restoration tool, peatland management and woodland ecology.

The Watershed Restoration Initiative and Fire

Alan Clark, Watershed Program Director, Utah Department of Natural Resources, Salt Lake City, Utah

Now entering its tenth year of completing landscape-scale projects in Utah, the purpose of WRI is to restore and improve watershed health in priority areas across the state. In 2014, with support of \$3.95 million from

the Utah Legislature, the WRI partnership (which included 91 partners) completed over 130 projects restoring 112,987 acres of uplands and 55 miles of stream and riparian areas. Since its inception, WRI partners have completed over 1,340 projects, treating over 1.15 million acres of habitat with an investment by all partners of over \$130 million. Almost all terrestrial projects carried out by WRI reduce the risk of catastrophic wildfire in the long-term by restoring the structure and function of systems. Some projects focused on treating invasive species including cheatgrass, tamarisk and Russian Olive as well as Stage 3 encroached pinyon/juniper stands provide an immediate reduction in the risk of destructive fires. Many projects have as their goal to reintroduce beneficial fire into these systems. Higher elevation prescribed burns are used to regenerate aspen systems. Finally, WRI works with its federal and state partners to rehabilitate watersheds after wildfires to restore structure and function and reduce the risk of future uncontrolled fires.

Alan G. Clark, Watershed Program Director, Utah Department of Natural Resources, 1594 West North Temple, Salt Lake City, UT 84114, phone: (801) 538-4876, email: alangclark@utah.gov

Alan was born and grew up outside of Dayton, Ohio. He received his bachelor's degree in Wildlife Science at the University of Maine. He went on to spend the next 23 years with the Maine Department of Inland Fisheries and Wildlife with a one year break to obtain a Master's in Wildlife Management Degree from Virginia Tech. He held a variety of positions in Maine including regional wildlife biologist, research biologist and assistant project leader, and wildlife planner. In 1996, Alan took on a new challenge and crossed the Rockies with his wife and three daughters to join the Utah Division of Wildlife Resources as the wildlife planning manager. Over the next 16 years he held other positions with UDWR including Wildlife Chief and Assistant Director. In December of 2012, Alan transferred to the Department of Natural Resources as Director of the Watershed Restoration Program and continued coordinating the development and implementation of the Utah Greater Sage Grouse Conservation Plan. Alan has been married to his wife Linda for 41 years. He has two living daughters and 5 grandchildren, one of which he and his wife are raising. He is interested in all things outdoors. He serves as President of the local water company in Erda and is a licensed water system operator and manager.

Understanding the Effects of the Twitchell Canyon Wildfire on Stream Geomorphology and Fish Habitat

Patrick Belmont, Assistant Professor, Department of Watershed Sciences, Utah State University, Logan, Utah

Collaborators: Keelin Schaffrath, Phaedra Budy, Colton Finch

Impacts of wildfire are highly variable; some areas experience only modest changes and are quick to recover while other areas incur profound changes to aquatic biota, in-stream habitat, water quality, watershed hydrology, hillslope erosion, and sediment transport. In some cases, these impacts only affect areas within or near the burned area, while in other cases the impacts are propagated far downstream. At present we have very limited ability to predict which parts of the landscape, and thus which populations of fish, are most likely to be negatively affected by fire. Similarly, we have little basis for projecting ecosystem recovery and prioritizing areas for fish populations. The Twitchell Canyon fire burned 45,000 acres near Beaver, UT in July 2010. Over 30% of the area burned at high severity, which included two major headwater streams that sustained a trout population. In summer 2011, monsoonal thunderstorms caused massive debris flows and sheet-flow erosion that altered channel morphology and aquatic habitat in the burned area. A previously robust, non-native trout fishery was nearly extirpated as a result of the geomorphic response to the wildfire. Extensive field observations were correlated with predictive models for post-wildfire debris flows and characteristics of the topography and topology of the watersheds. Watershed characteristics that appear to preclude negative impacts to fish habitat are slope and valley width. Where slopes flatten and valleys widen, sediments are deposited in a way that high quality fish habitat is buried. Radiocarbon dating of burned material and field observation were used

to determine the frequency of wildfire and its synchronicity over the Holocene. Our initial sampling campaign appears to document 10-15 individual wildfires and with age estimate spanning the recent half of the Holocene (~8,000 years).

Patrick Belmont, Watershed Sciences Department, Utah State University, 5210 Old Main Hill, NR 210, Logan, UT 84322-5210, phone: (435) 797-3794, email: patrick.belmont@usu.edu

Patrick Belmont is an Associate Professor of Hydrology and Geomorphology in the Department of Watershed Sciences, Utah State University. His research interests span watershed hydrologic modeling, sediment transport modeling, geochemical fingerprinting, using terrestrial cosmogenic nuclides to study Earth surface processes and long-term landscape change, and quantitative basin morphometric analysis.

Designing a Regional Network of Fuel Breaks to Protect Greater Sage-Grouse Habitat: An Experimental Approach using Circuitscape

Nathan Welch, GIS Analyst, The Nature Conservancy Boise Office, Boise, Idaho

The loss of sagebrush steppe to uncharacteristically large and frequent wildfires has been identified as a primary threat to Greater Sage-Grouse (GSG) populations in the western portion of the species' range. Policy documents regularly identify the need for landscape-scale approaches to design and implement fuel treatments (e.g., fuel breaks) to prevent loss of habitat to wildfires. In an effort to help federal and state agencies reduce the impact of large wildfires, we developed a GIS approach that uses Circuitscape to identify strategic locations for fuel breaks and simulate potential fuel breaks to protect remaining large patches of important GSG habitat. As a demonstration, we applied our experimental approach to a 27-million acre (110,000 km²) region that includes parts of Idaho, Nevada, Oregon, and Utah. We used the Circuitscape model to identify a set of strategic locations for fuel breaks and simulate potential fuel breaks with different levels of resistance to fire. We proposed six focal geographies in our Project Area for further investigation for designing and implementing fuel breaks. From the beginning, we knew the detailed design and implementation of fuel breaks would require close collaboration with public land fire managers. We have discovered that even preliminary design of a network of fuel breaks will require close collaboration with local experts, especially BLM fuels management staff. The participation of local experts and their support of the design process will be critical for success. Besides encouraging others to test our Circuitscape approach for modeling fuel breaks, we intend to pursue a collaboration with fire managers in at least one of the focal geographies we identified.

Nathan Welch, The Nature Conservancy, 950 W Bannock St. #210, Boise, ID 83702, email: nwelch@tnc.org

Nathan has provided GIS (Geographic Information System) services, including mapmaking, spatial analysis, data management and training, for The Nature Conservancy in Idaho since 2011. He has been using GIS to support land and water conservation in the western United States since 2007. Before joining the Conservancy, Nathan worked in central Idaho to conserve private lands, support collaborative conservation efforts, and advocate for conservation on local and regional land use planning issues. He is a scientist by training with a bachelor's degree in biology from Whitman College and master's degrees in ecology from Utah State and Duke Universities.

Monitoring the Impact of Climate Change on Fire Frequency and Severity in Great Basin Bristlecone Pine Sky Island Ecosystems

Mike Jenkins, Associate Professor, Quinney College of Natural Resources, Utah State University, Logan, Utah
High elevation five needle pines are rapidly declining throughout western North America due to warming

temperatures, mountain pine beetle, white pine blister rust, and alteration of the naturally occurring fire regime. The impact of climate change is especially acute in sky islands of the Great Basin as warming temperatures alter tree distribution and contribute to overstory tree mortality. Great Basin bristlecone pine forests occur as ecological islands at the highest elevations of mountain ranges separated by extensive rangeland or desert basins. Great Basin bristlecone pine ecosystems are highly fragmented and contain many biodiversity “hot spots” with a high degree of species endemism. It is the fragmentation history and the number and character of the sky islands that are key to understanding biodiversity of Great Basin bristlecone pine forests. This paper will address the effects of climate change on Great Basin bristlecone pine forests. Specifically we will discuss climate-induced changes to the fire regime through alteration of surface and canopy fuel loading, fire hazard and risk, and on predicted changes in fire behavior and severity. Secondly we will evaluate Great Basin bristlecone pine volatile organic compounds across elevation gradients to assess changes in tree biochemistry in response to climatic stress.

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*Dr. Jenkins is a Professor and Director of the Disturbance Ecology and Management Lab at Utah State University, studying the interaction of select agents of disturbance in conifer forests over large spatial and long temporal scales. In recent years research has focused on the relationship between bark beetles, fuels and fire behavior, and forest snow avalanches in Rocky Mountain and European Forests. Dr. Jenkins recently returned from an 18 month-long, seven continents world tour conducting research on his new book, *The Nature of Mountains*, an exploration of the ecological and cultural landscape of the world's great mountain ranges.*

Restoring Whitebark Pine Ecosystems of the West in the Face of Climate Change

Robert Keane, Research Ecologist, Rocky Mountain Research Station, USDA Forest Service, Missoula, Montana
Collaborators: Lisa Holsinger, Mary Mahalovich, Diana Tomback

The combined effects of mountain pine beetle (*Dendroctonus ponderosae*) outbreaks, fire exclusion policies, and the exotic disease white pine blister rust (caused by the pathogen *Cronartium ribicola*) has caused a severe decline in high elevation whitebark pine (*Pinus albicaulis*) forests across western North America. Predicted changes in climate may exacerbate this decline by (1) accelerating succession to more shade tolerant conifers, (2) creating environments unsuitable for whitebark pine, (3) increasing the frequency and severity of mountain pine beetle outbreaks and wildland fire events, and (4) facilitating spread of blister rust. Since more than 90 percent of whitebark pine forests occur on public lands in the U.S. and Canada, a trans-boundary, a range-wide whitebark pine restoration strategy was developed for public lands to coordinate and inform restoration efforts across federal and provincial land management agencies. In this presentation, we will discuss the fire ecology of this valuable ecosystem to provide a context for restoration. Then, the range-wide strategy will be presented and the full suite of restoration activities will be explored. Last, we will present guidelines for restoring whitebark pine under future climates using the rangewide restoration strategy structure. The information on adjusting whitebark pine restoration effects for climate change impacts come from two sources: we conducted a comprehensive review of the literature to assess climate change impacts on whitebark pine ecology and management and then we used the spatially explicit, ecological process model FireBGCv2 to simulate various climate change, management, and fire exclusion scenarios. The paper is written as a general guide to be used with the rangewide strategy for planning, designing, implementing, and evaluating fine-scale restoration activities for whitebark pine by public land management agencies by addressing climate change impacts. Robert E. Keane, Research Ecologist, US Forest Service Rocky Mountain Research Station, Missoula Fire Sciences

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Robert E. Keane is a Research Ecologist with the USDA Forest Service, Rocky Mountain Research Station at the Missoula Fire Sciences Laboratory. His most recent research includes 1) developing ecological computer simulation models for the exploring landscape, fire, and climate dynamics, 2) conducting field research on the sampling, describing, modeling, and mapping of fuel characteristics, and 3) investigating the ecology and restoration of whitebark pine. He received his B.S. degree in forest engineering from the University of Maine, Orono; his M.S. degree in forest ecology from the University of Montana, Missoula; and his Ph.D. degree in forest ecology from the University of Idaho, Moscow

Tree-Ring Reconstructions of Fire and Forest Histories: Providing the “What” and “Why” for Forest Restoration

Peter M. Brown, Director, Rocky Mountain Tree-Ring Research, Fort Collins, Colorado

Tree-ring reconstructions of fire and forest histories provide central evidence of long-term ecological dynamics in forested ecosystems, especially during periods before widespread human impacts such as fire suppression, logging, and grazing. These reconstructions also serve as models of resilient conditions that forest managers and scientists use to justify, guide, and assess ecological restoration efforts. In this talk, I discuss the development, use, and limitations of tree-ring reconstructions and how such data are informing forest restoration efforts using an example from the Front Range in Colorado. The Collaborative Forest Landscape Restoration Program (CFLRP) is a nationwide effort to promote science-based ecological restoration projects on National Forest frequent-fire forest landscapes. CFLRP projects are directed by multi-stakeholder groups who set goals for restoration treatments, assist in project implementation, and provide learning through adaptive monitoring. I will describe the process that the Colorado Front Range CFLRP has gone through in, first, assessing the level of historical data we possessed at the start of the project and, second, supporting a research program to define missing components including stand to landscape forest structural elements (species composition, tree densities and basal areas, and tree to landscape spatial patterns).

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Peter M. Brown is Director of Rocky Mountain Tree-Ring Research, a nonprofit corporation he founded in 1997. His research involves use of tree ring data to reconstruct fire, forest, and climate histories, and the application of those data to current issues in natural resource management and climate change. Current or recent studies are in the US, Mexico, Mongolia, China, and India. He received his PhD from and is an Affiliate Faculty member at Colorado State University. He is also past President and current Executive Director of the Tree-Ring Society, an international organization of tree-ring scientists from over 50 countries.

Of Fire, Sage Grouse and Our Federal Lands

John Freemuth, Professor of Public Policy and Senior Fellow for Environment and Public Lands, School of Public Service, Boise State University

This presentation will explore the political, policy and science landscape of sage grouse, the sage brush steppe ecosystem and fire. It will discuss what has happened since the November 2014 conference The Next Steppe, held in Boise and the authors presentation there, “Why All this Matters.”

John Freemuth, Environmental Research Building, Room 5137, Mail Stop 1935, Boise State University, 1910

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John Freemuth is Professor of Public Policy, Boise State University. His primary academic interest is with the public lands of the United States. Currently his work gravitates towards puzzling out the relationship between science and public policy as it relates to issues surrounding the public lands. He wrote "Thoughts on the Role of Science in Public Policy Making" in Ecology and Conservation of Greater Sage-Grouse: A Landscape Species and Its Habitats (University of California Press, 2011). He is working on two other projects, one a revision of his and Zachary Smith's Environmental Politics and Policy in the West (UC Boulder,) and, the second, a set of essays titled "Public Lands in the Age of Ecology". He chaired the Science Advisory Board of the Bureau of Land Management, after being appointed by Interior Secretary Bruce Babbitt. He was the Senior Fellow at the Cecil Andrus Center for Public Policy from 1998-2011, and returned as Senior Fellow for Environment and Public Lands in February, 2015. He is principal investigator on a grant from the United States Geological Survey working on improving the policy utility of GAP Analysis, Species Modelling and Protected Area data. He has also been a high school teacher, seasonal park ranger and IRS Revenue Officer. While a ranger, long ago, at Glen Canyon National Recreation Area he wrote "Wanderer for Beauty: Everett Ruess in the Glen Canyon Area", a park interpretive handout and is glad Everett has yet to be found. He has a BA from Pomona College and a Ph.D. from Colorado State University. He was named the Carnegie Foundation for the Advancement of Teaching /CAES of Professor of the Year for Idaho for 2001.

Past and Future Wildfire in the Interior West as Predicted by the Calibrated Combustion Dynamics of Ecosystems

Richard Guyette, Associate Research Professor, School of Natural Resources, University of Missouri

Collaborators: F. Thompson, D.C. Dey, M.C. Stambaugh

Society is confronted with the effects of climate on wildland fire regimes in ecosystems. We use an ecosystem combustion model (PC2FM) developed with atmospheric variables to predict and simulate fire probability. Precipitation, temperature, and oxygen, three major climate variables that affect the combustion dynamics in ecosystems, are used to address climate forced variance in fire frequency. The use of ecosystem fire metrics in combustion chemistry and physics offers a quantitative method for estimating wildland fire intervals and probability in addition to the well-studied forcing by topography, ignition, and vegetation. Here we apply a combustion process model calibrated with a large empirical fire scar data set. Exothermic reactions and rate laws are used to formulate, map and graph wildland fire dynamics. Past and future maps of fire intervals are presented and discussed. Model results are graphed in a simulated 'climate space' that includes temperature and the dual effects of water in ecosystem combustion: 1) the production of carbon bonds (fuel) and 2) the inhibition of collision frequency. These contrasting processes of water in ecosystems define Switch Over Loci (climate sensitive 'tipping points') that estimate fire probability classes such as: 1) precipitation insensitive, 2) precipitation unstable, and 3) precipitation sensitive. Most of the area in the Interior West falls into category 2 (precipitation unstable) and 3 (precipitation sensitive) because of low moisture and high temperatures.

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Dr. Guyette is a Research Professor in the Department of Forestry in the School of Natural Resources, at the University of Missouri. He has degrees in Anthropology and Forestry. He has been working on environment change for over 35 years with techniques in dendrochronology and chemistry. He has published over 57 peer reviewed articles on wildfire, environmental chemistry, and human ignitions. His present interests are in the

combustion dynamics of ecosystems.

Bringing Back the Trout: Metapopulation Viability of Bonneville Cutthroat Trout in a Fire-Impacted Watershed

Colton Finch, PhD candidate, Department of Watershed Sciences and Ecology Center, Utah State University
Collaborators: Phaedra Budy, Patrick Belmont

Wildland fires are becoming more frequent, larger, and more severe as forested western landscapes adjust to a warmer and drier climate and elevated fuel storage due to decades of fire suppression. Although native fish communities co-evolved with and are resilient to natural fire perturbations, uncharacteristic fires can be at odds with fish conservation, especially in physically or biologically fragmented modern watersheds. We estimated the extinction rate of a Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) metapopulation under modeled future fire regimes on Fishlake National Forest in south-central Utah. We parameterized this model to include demographic stochasticity, movement between subpopulations, and occurrence and synchrony of fire by drawing values from a normal distribution centered on realistic mean values (published or estimated). We simulated these values for each year of a 100-year period using a matrix population projection. We conclude that resilience of Bonneville cutthroat trout metapopulations increases with increased subpopulation connectivity and reduced synchrony of fire perturbations. Managing native fish populations to increase resilience to wildfire should include removal of barriers, if possible, as well as promoting asynchronous fire occurrence to allow discrete subpopulations of fish to recover and contribute to overall metapopulation stability.

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Colton Finch was raised on a public-land cattle ranch in Arizona and experienced the struggles and successes of natural resource management, including the need for sound science in management. He graduated from University of Arizona with a degree in Natural Resources in 2009. Colton then earned his MS from University of Florida studying how experimental hydropower regimes affected native fishes in Grand Canyon before coming to Utah State to investigate the impact of wildland fires on aquatic species. Colton is especially interested in how science can inform and improve landscape-scale conservation; some of his other interests are invasion ecology and animal behavior.

Post-fire Grazing Management of Sagebrush Steppe Plant Communities in the Great Basin

Jeffrey Gicklhorn, Research Assistant, University of Nevada Reno, Reno, Nevada
Collaborators: Kari Veblen, Beth Newingham, Jon Bates, Eric LaMalfa

Wildfire size and frequency is increasing in the Great Basin, which requires adjustments in management to allow for ecosystem recovery. Domestic livestock grazing is a major land use in the region, and sustainable post-fire grazing management practices that ensure productive and resilient sagebrush steppe communities are essential to successful ecosystem recovery. Recovery hinges on the growth, reproduction, and recruitment of perennial understory plants, especially bunchgrasses. Perennial grasses provide forage and habitat, increase resistance to invasion, and assist with soil stability and hydrologic function. Here we review the available post-fire grazing literature and provide guidelines for maintaining productive sagebrush steppe communities in grazed areas after fire. Recommendations include: 1) delaying grazing until defined site objectives have been met, 2) delaying grazing until after seed maturity or shatter to promote bunchgrass recovery, 3) instituting

an appropriate rotation system to maintain plant production, cover, and composition, and 4) implementing regular monitoring and assessment protocols to determine grazing regime effectiveness.

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Jeff Gicklhorn is a master's student at the University of Nevada, Reno working with Dr. Beth Newingham (USDA-ARS). His current research examines how post-fire grazing management affects the recovery of seeded sagebrush rangelands. He has spent the past five years working in both research and management in the Great Basin and Mojave, and strives to integrate knowledge from both in exploring effective and efficient ecological restoration practices.

Unraveling Fire and Herbivore Interactions to Manage Tree Cover in an African Savanna

Eric LaMalfa, PhD Candidate, Wildland Resources Department, Utah State University

Collaborators: Duncan M. Kimuyu, Ryan L. Sensenig, Corinna Riginos, Truman P. Young, Kari E. Veblen

Savanna ecologists continue to debate the relative importance of fire and herbivory disturbances in affecting local savanna tree cover and applied issues such as “bush encroachment”. Contemporary grass-tree co-existence models and a large body of literature emphasize the importance of both top-down disturbance types. However, no fully replicated experiments have simultaneously manipulated fire and herbivore regimes to directly examine potentially synergistic interactions controlling tree demography. We hypothesized that the “fire trap” wherein trees are repeatedly top-killed by fire and prevented from transitioning to taller fire resistant height classes, is further reinforced by the negative effects of ungulate browsing on tree height. Conversely, grazing by livestock or the absence of all herbivory was expected to increase height and biomass of re-sprouting trees after fire. We used the Kenya Long Term Exclosure Experiment (KLEE), which for the past 20 years has restricted access by six different combinations of mega-herbivores (i.e., elephant and giraffe), meso-wildlife (e.g. gazelle, oryx, cape buffalo), and cattle. Within each of 18 four-ha KLEE plots a 30 X 30 meter prescribed burn was implemented in 2013. We used linear regression models to compare pre-fire tree height and post-fire tree re-sprout height and morphology relationships among the six different herbivore treatments. One and a half years after the fires, the relationship between pre-fire tree height and post-fire tree height was dependent upon both the herbivore treatment and colonization by ant mutualists that defend trees against browsing. In the presence of wildlife (i.e. browsers) trees compensated for lost tissue by increasing the number of lateral basal stems. We expect that these shorter multi-stemmed growth forms will have prolonged susceptibility to future fires reinforcing the negative effects of fire on tree cover. These results highlight that long term changes in tree cover may be dependent upon the stocking rate/ density of both wild and domestic herbivores following disturbance.

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Eric LaMalfa is currently a Quinney Research Fellow pursuing a PhD in Ecology at Utah State University (USU). His dissertation focuses on herbivore-plant-fire interactions in a multi-use savanna rangeland in East Africa. Eric previously completed a master's degree at USU, where he studied the ecophysiology of mixed aspen/coniferous forests of northern Utah and helped to develop a community based, fire-management program for pastoralists in Ethiopia. Prior to returning to USU for his PhD, Eric worked as a fuels management specialist with both the Bureau of Land Management (BLM) and US Forest Service (USFS).

Public and Agency Perceptions of Smoke from Wild and Prescribed Fire

Christine Olsen, Research Associate and Instructor, Department of Forest Ecosystems and Society, Oregon State University, Corvallis, Oregon

Smoke is a growing concern for communities as well as land and air quality managers. It affects air quality across landscapes much larger than the originating fire and can have significant negative impacts on nearby communities. Earlier this year, the U.S. Environmental Protection Agency (EPA) released proposed rules for how states will work to meet the ambient air quality standards for particulate matter, which were lowered in 2013. At the same time, wildfires seem to grow in number and size every year, producing major smoke impacts on communities across the country, and underscoring the need to reduce fuels on unburned landscapes to reduce the risk of future fire events. Managers and landowners wishing to use fire as a tool for fuel reduction (i.e., prescribed fire, pile burns) could face significant barriers, both because of air quality standards and because of public concern for smoke impacts. Accordingly, it is important to understand public beliefs regarding smoke, especially focusing on what factors may influence acceptance of smoke emissions. In this presentation I will present findings from three projects funded by the Joint Fire Science Program, the Western Wildland Environmental Threat Assessment Center (WWETAC), and the National Science Foundation. Data includes interviews among forest and fire managers, air quality regulators, and some community group members, as well as public survey data from dozens of communities across the country. This presentation will focus on the major challenges identified by interview participants regarding smoke management, communication strategies that were identified as useful for overcoming these challenges, and factors that may influence public tolerance of smoke from different sources (e.g., wildland fire, prescribed fire, agricultural burns).

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Christine Shaw Olsen, Ph.D., is a Research Social Scientist and Instructor in the Department of Forest Ecosystems & Society at Oregon State University in Corvallis, Oregon. Dr. Olsen is co-investigator of the Northwest Fire Science Consortium and conducts research on citizen-agency interactions, public opinions about fire and fuel reduction activities, and communication and education about forestry and fire. Her most recent projects examine public perceptions of smoke, citizen-agency trust, and coupled human-natural systems in fire-prone landscapes. A newly-funded project looks at fire weather modeling and manager decision-making. Dr. Olsen teaches classes about forest management for multiple resource values, managing in the wildland-urban interface, sustainable natural resource management, and social science methods.

The Role of Prescribed Fire Councils in Restoring the West

J. Morgan Varner, Assistant Professor, Department of Forest Resources & Environmental Conservation, Virginia Tech, Blacksburg, Virginia

Prescribed fire faces challenges to its use as a widespread ecological restoration tool in many fire-prone western North American ecosystems. The primary challenges to prescribed fire use include social, regulatory, and operational impediments. Prescribed Fire Councils (PFCs) are a mechanism utilized across the US to maintain and increase the use of prescribed fire, to increase outreach and science delivery, to engage stakeholders, and increase peer-to-peer education. PFCs were developed in the southeastern US and have recently expanded into western states and British Columbia. PFCs are diverse and represent place-relevant

constituencies and the issues that the prescribed fire communities face. PFCs offer a way forward to increase and improve prescribed fire as a cultural, silvicultural, and restoration tool.

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Morgan Varner is on the faculty of Virginia Tech, where he teaches and leads research on fire and forest ecology of North American savannas, woodlands, and forests. He serves as Chair of the Coalition of Prescribed Fire Councils that represents 30 regional organizations across the US and Canada focused on prescribed fire use and education.

Use of Livestock to Mitigate Risk of Wildfire

Troy Forrest, UDAF-Grazing Improvement Program Program Manager - Northwest Region Coordinator Utah Grazing Improvement Program Director, Utah Department of Agriculture and Food, Salt Lake City, Utah

We will discuss several ways that domestic livestock and managed grazing can be used to prevent wildfire. We will discuss season's of use, stocking density, types of livestock to be used and successful methods of using grazing to reduce fine fuel loads and thereby reduce the risk of wildfire. We will also discuss using livestock for establishment of green strips.

Troy Forrest, Utah Grazing Improvement Program, Utah Department of Agriculture and Food, 350 N Redwood Road, PO Box 146500, Salt Lake City, UT 84114, phone: (435) 279-3603, tforrest@utah.gov

Mr. Forrest was raised in Monticello, Utah, where his parents still reside. Growing up Troy had the opportunity to work with his Grandpa and Uncle on the family ranch and to watch his Dad while he worked with local ranchers as a Range Conservationist for the US Forest Service. This instilled a love of ranching and the outdoors and led Troy to pursue a Degree in Range Management at Utah State University. Prior to attending USU he attended Snow College in Ephraim, where he was fortunate enough to find and marry his wife Mailee. They along with their 4 boys currently reside in Tremonton, Utah. Mr. Forrest currently works as the Program Manager for the Utah Grazing Improvement Program at the Utah Department of Agriculture and Food. He has been involved with the Grazing Improvement Program since its inception and continues to serve as the Regional Coordinator for the Northwest Region, which consists of Box Elder, Cache, and Rich Counties. Prior to working for UGIP Troy worked as a conservation planner for the Utah Association of Conservation Districts in Tremonton since 1998.

Fire, Rain, and Post-Fire Restoration of Sagebrush Steppe in the Great Basin

David S. Pilliod, Supervisory Research Ecologist, Forest and Rangeland Ecosystem Science Center, US Geological Survey, Boise, Idaho

Seeding rangelands, particularly after fire, is a common practice in sagebrush steppe habitats of the Great Basin. We summarized historic trends of 5,450 seeding treatments in the Great Basin from the 1940s to present and examined relative levels of success for a subset of projects in relation to long-term precipitation patterns and subsequent fires. Preliminary results suggest that large fires often occur the summer following a high precipitation event, probably because of an increase in fine fuel loads. Soil stabilization or rehabilitation seedings in the fall or spring after a fire often occurred when precipitation was lower than normal, possibly contributing to lower than expected germination and seedling survival. These patterns suggest that post-fire seeding in the Great Basin over the last 75 years may have been hampered by low rainfall in the years

following fire. Subsequent fires that re-burn seeded areas further complicate restoration of sagebrush steppe in the Great Basin. We found that more than 40% of seeding treatments have reburned since 1940, usually within 10 years of seeding. These results suggest that restoring sagebrush steppe to the Great Basin faces many challenges, but perhaps allowing more flexibility in the timing of seeding after fire may be a first step towards increasing probability of success.

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My research focuses on the ecology, restoration, and conservation biology of aquatic and terrestrial ecosystems. I became interested in the effects of fire and fuel management after the big fire year of 2000 when I was working as post-doctoral researcher the USDA Rocky Mountain Research Station in Missoula, Montana. My research transitioned from forests to rangelands in 2006 when I began working for the US Geological Survey Forest and Rangeland Ecosystem Science Center in Boise, Idaho. I am particularly interested in working with agencies to improve monitoring data and use those data to answer questions regarding effects and effectiveness of land use, resource management, and restoration.

Insights into Fire Severity and Post-Fire Recovery from an Integrated Analysis of Forestry Inventory Data and Long-Term Fire Mapping Datasets

Sara Goeking, Biological Scientist, Forest Service, Rocky Mountain Research Station, Inventory and Monitoring Program

Collaborators: John Shaw, Jim Menlove, Charles Werstak, Jr.

Plot data from the Forest Inventory and Analysis (FIA) Program can be combined with spatially explicit polygon data from the Monitoring Trends in Burn Severity (MTBS) Program to provide insights into fire effects, fire severity, and long-term recovery in forested areas. MTBS delineates two main products: burned-area polygons that provide a census of large fires from 1984 to the present, and severity layers with 30-m resolution, where each pixel is classified into one of four major severity classes, ranging from very low or unburned to high-severity fire. We spatially intersected FIA's plot data with both MTBS datasets to quantify fire effects in three ways. First, a characterization of burned areas throughout our 8-state study area showed that 41% of the acreage of large fires since 1984 burned on forest land, and the most commonly burned stands were in ponderosa pine, lodgepole pine, and Douglas-fir forest types. Nearly 35% of post-fire plots had no live basal area of trees $\geq 5''$ diameter remaining. Second, we examined the relationship between time since fire and basal area, seedling density, and sapling density at FIA plots. Survivor trees experienced low post-fire mortality rates, and almost half of post-fire dead basal area persisted for up to 25 years after fire. Seedling density peaked 5 to 10 years after fire, while sapling density increased steadily for at least 25 years post-fire. Third, we identified FIA plots that were measured both pre-fire and post-fire, and then compared mean post-fire reductions in live basal area by MTBS severity class. Plots that experienced high-severity fire had higher pre-fire basal area than plots that burned at lower intensities. At a regional scale, post-fire reductions in live basal area were significantly different across the four MTBS severity classes, although severity classes were less distinguishable for individual forest types.

Sara Goeking, Interior West Forest Inventory and Analysis (FIA) Program, Rocky Mountain Research Station, USDA Forest Service, 507 25th St., Suite 300, Ogden, UT 84401, email: sgoeking@fs.fed.us

Sara Goeking is a Biological Scientist with the US Forest Service's Forest Inventory and Analysis Program (FIA) in Ogden, Utah. She seeks to develop spatially explicit applications of FIA data that will enhance understanding of forest dynamics such as regeneration, mortality, and land use/land cover change. Her current projects involve

developing methods for comparing historical and recent forest inventory datasets, mapping trees in nonforest areas, assessing whitebark pine distributions in mixed-species stands, and applying robust forest monitoring techniques in developing countries. In her spare time, she makes things out of wood and farms powder lines in the Bear River backcountry.

Quaking Aspen: a Burning Desire in an 'Asbestos Forest'

Paul Rogers, Director, Western Aspen Alliance, Adjunct Associate Professor, Utah State University, Logan, Utah
Collaborator: Kevin Krasnow

Media reports of quaking aspen's doom are common in the western U.S. We're told aspen is dying 'from Alberta to Arizona' or that the future of aspen is bleak with projected climate change. "Aspen decline" - defined variously over recent decades by waves of prognosticators - is caused by cool wet climates, warm dry climates, fire suppression, livestock, elk, fir encroachment, rampant development, ozone, recreation, and radio waves. What is the actual situation with aspen and how might we expect this far-flung species to react to projected changes? Climate, in partnership with shorter-term weather events, has the strongest influence on wildfire occurrence. Many, not all, aspen forests will be subject to fire's increasing influences as the climate heats up. In this presentation we will explore expected impacts on aspen ecosystems under changing climates, with an emphasis on aspen fire types. Secondarily, we will discuss aspen's response to fire and how that varies considerably based on many factors. A broader aim is to emphasize unique fire-related systems and to wean practitioners from one-size-fits-all prescriptions for aspen forests.

Paul Rogers, Director Western Aspen Alliance, Adjunct Associate Professor - Wildland Resources Department, Ecology Center Associate, Utah State University, Old Main Hill, Logan, Utah 84322

Paul holds a B.S. and M.S. in geography from Utah State University and University of Wisconsin – Madison, respectively. His doctorate is from Utah State University in Ecology. Paul's prime area of study has been human impacts on vegetation in the western United States. He worked for the U.S. Forest Service for 16 years conducting monitoring activities and publishing results from the Interior West of the U.S., in eastern Europe, and East Africa. Paul's research on lichens and forests has taken him around the region, as well as to Europe and Australia. He is currently working on issues related to wildlife impacts and benefits to aspen ecosystems; he has published more than 40 professional and technical papers. He is an Adjunct Associate Professor in the Department of Wildland Resources, a USU Ecology Center Associate, and the Director of the Western Aspen Alliance. Paul has taught Environmental Problem-Solving, Natural Resource Monitoring, and Planet Earth for honors students.

Poster Abstracts

In alphabetical order by presenting author's last name

Quantifying Fuels Along Successional and Invasion Gradients in Sagebrush Ecological Sites of the Great Basin

Robert Arkle, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, Idaho

Co-authors: Douglas J. Shinneman, David S. Pilliod, Susan K. McIlroy, and Nancy F. Glenn

In many sagebrush landscapes of the Great Basin, fire and invasion by nonnative plants can alter successional trajectories and create dynamic fuel conditions. Poorly quantified or constantly changing plant communities and fuel conditions hinder attempts by land managers to predict and control fire behavior, restore native plant communities, and maintain ecosystem services. We assessed how fuel loads change along successional and invasion gradients and across years in sagebrush ecological sites throughout the Great Basin. Preliminary results suggest that successional stage (i.e., prevalence of shrub cover) had a large effect on herbaceous biomass. On average, areas with $\geq 10\%$ shrub cover had 57% less herbaceous biomass than areas with $< 10\%$ shrub cover. When shrubs were absent, increasing bunchgrass cover did not have a strong effect on herbaceous biomass, likely because nonnative annuals accounted for more biomass when bunchgrasses were sparse. An invasion gradient (i.e., prevalence of nonnative plants) had a stronger effect on herbaceous biomass than did successional stage. In some invasion-prone areas (e.g., Snake River Plain), cover of nonnative forbs (*Sisymbrium altissimum*, *Salsola tragus*) contributed substantially more herbaceous biomass than did cheatgrass (*Bromus tectorum*). Down woody debris was infrequently encountered and did not contribute appreciably to fuel loads regardless of the successional stage. Inter-annual variability in herbaceous biomass was substantial (e.g., 45% change between years) and correlated with annual precipitation. Below average precipitation led to not only reductions in annuals, but also reductions of perennial grass cover (e.g., *Poa secunda*). However, herbaceous biomass varied less between wet and dry years in sites with relatively high shrub cover ($> 20\%$) than in sites with little or no shrub cover ($< 5\%$). Preliminary findings such as these could help land management agencies predict dynamic fuel conditions, fire risk, and fire behavior across the large landscapes they manage.

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Long-Term Perspectives on Aspen-Fire Dynamics

Vachel Carter, Department of Geography, University of Utah

Co-authors: Jesse L. Morris, R. Justin DeRose, Andrea Brunelle, Johnny Israelsen

In the US Rocky Mountains, aspen is considered a keystone species that supports communities of high biological and genetic diversity. Generally, aspen communities can be characterized as either stable or seral, each supporting distinct fire regimes. While multiple possible aspen fire regimes have been postulated, they are based on limited, observational or tree-ring-based studies. New datasets are necessary to elucidate how aspen vegetation dynamics and fire regimes will respond to directional climate change that has the potential to reorganize vegetation communities and promote shifts in fire regimes over longer time scales. Paleoecological reconstructions provide fundamental information of baseline environmental conditions that contributes to a fuller understanding of the broad-scale, long-term patterns of past disturbance and vegetation

changes in aspen-dominated systems. Specifically, lake sediment studies relying on pollen and charcoal provide information about past vegetation composition and fire histories in many conifer-dominated systems. However information specific to aspen ecosystems are underrepresented in environmental reconstructions, despite their ecological significance. Our objective is twofold: 1) Using pollen records, how can we distinguish stable from seral aspen communities in long-term ecological reconstructions? and 2) By combining pollen and charcoal records, can we determine the possible role of fire in promoting, maintaining, or inhibiting aspen-dominated communities? We examine paleoecological data from several subalpine lakes in the central Rockies to help us understand climate-mediated aspen-fire dynamics over centennial to millennial timescales.

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USFS Landscape Restoration: Finding a Way to Celebrate our Success

Jen Croft, Applied Forest Ecologist, Fuels and Fire Ecology, USFS-Washington Office

The USDA Forest Service Fuels and Fire Ecology Program supports the goals of the National Cohesive Wildland Fire Strategy: restore and maintain resilient landscapes; develop fire adapted communities; and respond to wildfire safely, effectively and efficiently. As the dynamic nature of fire continues to challenge fire and fuels managers to strategically place treatments and modify landscapes effectively, the ability to capture and celebrate our success is an even more daunting task. We seek to create resilient landscapes in which fire can more appropriately play its ecological role, by working collaboratively across agency and ownership boundaries to build on common goals of protecting human life, sustaining communities, and creating healthy ecosystems. The monitoring and reporting measures for our fuels and fire ecology program are being modified to assist users in the effort to better capture agency success stories and provide a learning network for our resource managers. We focus restoration efforts on fire-adapted ecosystems to reduce the uncharacteristic intensity, severity, and adverse impacts of wildfire, particularly in dry forests proximate to communities, or important water supplies or other highly valued resources that are adversely impacted by fire, or located strategically to provide opportunities to manage wildfire to achieve resource benefits.

Fuels managers of the future will need to embrace the reality that fire can be restored within its appropriate ecological role while assisting fire managers in providing a blended response. The ability to truly restore the landscape will be determined by the ability to incorporate ecological principles that create healthy ecosystems while enhancing the ability to provide for public and fire fighter safety.

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Riparian Post-Fire Response: Factors Influencing Vegetation Recovery and Channel Stability

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The Bureau of Land Management (BLM) Emergency Stability and Rehabilitation Handbook suggests a rest from grazing following wildfire for two years or until objectives are met for the recovery of vegetation and key processes. It is important to understand and predict riparian response to fire since wildlife, humans, and livestock production all depend on riparian functions for food, habitat, recreation, and water. Long duration grazing restrictions cause economic hardships in rural Nevada communities that depend on public land livestock grazing, yet land managers must consider multiple uses and the

functionality of riparian systems. Little research focuses on post-fire riparian response and how recovery varies among stream types or in relation to condition, attributes, and drivers. To quantify stream recovery, we use the protocol Multiple Indicator Monitoring (MIM) of Stream Channels and Streamside Vegetation (Burton et al. 2011). It is becoming a standard method for quantifying riparian objectives. We do so at 24 streams across Nevada BLM lands burned in 2012 fires. We focus on reaches of management concern (e.g., functional at-risk, threatened species habitat, or aspen stands). Five sites are recovering aspen stands and fifteen were rated as functional-at-risk during a proper functioning condition (PFC) assessment performed within ten years prior to the fire. Long term MIM indicators include greenline plant composition (stability rating and wetland indicator value), woody species height class, streambank stability and cover, woody species age class, and greenline-to-greenline width. We evaluate the predictive ability among indicators, and investigate how streams vary in response among stream types, grazing history, position in the watershed, hydrogeomorphic interactions, prior condition and phases of the gully evolution cycle.

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Long Term Fire Effects on Vegetation Composition and Fuel Loads in Sagebrush-dominated Ecosystems

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The sagebrush steppe is among the most endangered ecosystems in western North America due to land use change, altered fire regimes, invasive species, overgrazing, and climate change. A large gap in our understanding of ecosystem response to fire in the sagebrush steppe has been a lack of data describing the effects of fire on plant composition and fuel loads in time frames longer than the first couple growing seasons following fire. To address this need, we quantified the influence of past fires (12-30 years) on current vegetation composition and fuels accumulation in intact sagebrush plant community types (mountain, Wyoming, and basin big sage and low sage) across the northern Great Basin. Native herbaceous vegetation dominated mid-succession recovery in all communities. Invasive grass cover declined with time since fire, and was low in all sagebrush types. Shrub regeneration was evident in all communities, with more woody cover in mesic mountain big sagebrush communities (17-20% cover) 10 years after fires than in arid Wyoming big sagebrush communities (<5%) 17 years after fires. By 25 years after fire, fuel accumulation had not reached levels of unburned controls in any sagebrush community. Collectively, our results describe differences in vegetation and fuels recovery by community type with time since fire but show overall sagebrush ecosystem resilience to fire at long temporal scales.

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Attributing Causes of Wildfire, Vegetation, and Hydrologic Climate Change Impacts

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The potential biases in climate data sets can drastically affect our ability to attribute climate change impacts. The recent release of a bias corrected gridded air temperature dataset for the continental U.S., TopoWx, provided an opportunity to quantify the effects of a climate model bias on ecological process-

based simulations. Here we present preliminary results from modeled vegetation metrics, hydrographs, and wildfire frequency driven by Daymet compared to TopoWx regional temperature datasets, using the dynamic vegetation model, LPJ-GUESS. LPJ-GUESS simulates plant physiological and biogeochemical mechanisms to simulate plant establishment, growth, competition, mortality, and soil hydrological processes. In addition, surface and subsurface runoff from each 1km² gridcell was input into an external routing model to create hydrographs. Simulations were run for the entire Greater Yellowstone Ecosystem to detect potential impacts of artificial climate trends at elevations above 1500 meters.

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Why Does Exposure to Wildfire Smoke Alter Tree Chemistry?

Curtis Gray, PhD Student, Utah State University

Co-authors: Justin B. Runyon, Michael J. Jenkins

We observed a large spike in terpene emissions and a reduction in concentration of within-needle terpenes while sampling volatile organic compounds (VOCs) from Great Basin bristlecone pine, GBBP (*Pinus longeava* Bailey) and limber pine (*Pinus flexilis* James) during the Carpenter 1 Fire (July, 2013) on Mount Charleston northwest of Las Vegas, Nevada. We hypothesize that exposure to smoke induced the observed changes in terpene emissions and concentrations. We tested this hypothesis by applying smoke to trees and measuring subsequent changes to VOCs and foliage flammability. Smoke from smoldering conifer needles was applied hourly (5 min per hour) to an apical branch (45 cm) of four GBBP and four limber pines using commercial bee smokers. VOCs were then measured from each branch and from four unsmoked control trees from each of the two species (GBBP and limber). We found that VOCs from the branches exposed to smoke increased approximately 3 fold over the controls during the 42 hour test period. In the laboratory, foliar fuel moisture and flammability of the needles from each treatment was measured (fuel moisture, time to ignition, duration of flaming, temperature at ignition, and maximum temperature). Of the variables measured only fuel moisture showed statistically significant differences. To determine if observed VOC response is unique to conifers we repeated the experiment using tomato plants (*Solanum esculentum*). Smoke-induced changes in VOCs may have important consequences for tree flammability and increased exposure to smoke may stress trees affecting the tree's natural defenses.

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Interpreting Fire, Vegetation and Climate for the Bonneville Basin, Utah During the Last ~36,000 Cal YR BP

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The Bonneville lake basin of northwestern Utah acts as a significant source of paleoenvironmental data due to the sedimentary and geomorphic evidence left behind from the late Pleistocene Lake Bonneville. Macroscopic charcoal and pollen from wetland sediments of North Redden Springs, Utah (40° 00' 47.1" N 113° 41' 59.9" W) were used to reconstruct a record of past fire and vegetation, along with local and regional climatic changes during the last 36.8 cal ka BP. Changes in charcoal (particles/cm²/yr), and high peak magnitudes (calculated from CharAnalysis), as well as the percentages of total pollen and pollen influx were used to interpret fire, vegetation and climate dynamics. During the latest Pleistocene (36.8- 29 cal ka BP), a cold and dry adapted sagebrush steppe surrounded Lake Bonneville, with no fire episodes due to the inundation of the

study site by Lake Bonneville. A subsequent increase in winter precipitation from the southward shift of the polar jet stream during the late Pleistocene (29- 16 cal ka BP) resulted in the expansion of a conifer forest and deeper lake levels. One fire episode occurred at 21 cal ka BP and is associated with a wet period followed by abrupt warming. Greater fuel sources correspond to increased fire episodes during the middle and early Holocene (16- 6.0 cal ka BP), when the climate was transitional between glacial wet/cold to interglacial warm/dry climate conditions. As early as 16 cal ka BP, a xeric shrub steppe composed of halophytic *Amaranthaceae* (e.g. shadscale, saltbrush and greasewood) vegetation dominated large expanses of playa around the North Redden lake-wetland complex. The late Holocene (6.0 cal ka BP- present) was characterized as a period of increased aridity, interspersed with cool-wet episodes. A xeric shrub steppe (*Amaranthaceae*) expanded its range to become the dominate vegetation type on the landscape. Substantial increases in aquatics and other diversified vegetation types also occurred in response to increases in summer moisture. Fires continued to increase in frequency and intensity throughout the historical period. Mechanisms behind fire activity likely included wet climate episodes, which provided ample fuel sources, while subsequent dry climate episodes provided ignition sources. Additionally, anthropogenic burning, fire suppression, and invasive plant species may have contributed to increased fire activity.

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Documenting Recovery of a Stream/Riparian System at the Jordan River Migratory Bird Reserve

Allison Jones, Executive Director, Wild Utah Project

Co-authors: Karri Smith, Chris Cline, Maureen Wilson

Great Salt Lake Audubon (GSLA) has been enhancing/restoring approximately 130 acres of riparian habitat at the Jordan River Migratory Bird Reserve (JRMBR) in South Jordan, UT since 1998. In 2007, GSLA and the Utah Reclamation, Mitigation and Conservation Commission (URMCC) re-aligned Little Willow Creek through a portion of the reserve. Little Willow Creek primarily receives streamflow from the Wasatch Mountains and urban stormwater runoff. Restoration activities conducted since 1998 include salt cedar and Russian olive eradication, willow and cottonwood plantings, and upland shrub plantings. In 2011, Allison Jones, Chris Cline, and the GSLA restoration team conducted a baseline stream/riparian function survey with the Rapid Stream-Riparian Assessment Protocol (RSRA) along Little Willow Creek to assess channel and riparian conditions four years post construction. During mid-2013 through 2015, beaver were welcomed on the reserve by GSLA and the new Reserve Manager Karri Smith. Additionally, beginning in December 2013, large-scale restoration planting, seeding, and weed control activities were implemented to bring restoration of the entire 130-acre reserve to completion. In 2015 Little Willow Creek was resurveyed using RSRA. This reassessment of the 2011 baseline stream reach detected significant in-stream channel condition and riparian and wetland habitat improvement. Overall improvements include: decreased non-native tree cover, increased channel shading, increased floodplain connectivity (at bank full), improved vertical bank stability, increased hydraulic habitat diversity, increased under bank cover, and increased shrub cover, mid-canopy cover/patch density, riparian tree demography/recruitment, and fluvial habitat diversity. It is the opinion of the Reserve Manager and co-authors that beaver are responsible for a significant degree of the observable improvements and the significant increase in field indicator scores when comparing the 2015 RSRA assessment to the 2011 assessment. Large-scale restoration plantings and management has also hastened restoration of Little Willow Creek and the greater Jordan River Migratory Bird Reserve.

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Restructuring Wildland Fire Management for an Army Training and Testing Center in Cheatgrass-Dominated Landscapes

Elizabeth Kellogg, President, Tierra Data, Inc.

Co-authors: Robert Knight, Brenna Vredevelde, Robert Wolf, Richard Montague, Patrick Carnahan, James Lockman, Shelby Law, Todd Kimmell

Maintaining flexibility for military training, while protecting life, facilities, and natural resources can present labyrinthine tradeoffs for managers facing wildfire threats. This is especially true at Dugway Proving Ground, where wildfire can convert sagebrush into cheatgrass-dominated landscapes. To maintain flexibility for military training while limiting ignitions, we developed a new fire danger announcement system using the Energy Release Component (ERC) from three on-installation RAWS, and wind speed using 25 Dugway meteorological stations. Fire danger categories were created using local meteorological records, fire history, and fuel models. These categories are Dugway-specific as they categorize fire danger according to firefighting resources, and provide precautions for training activities. This system provides flexibility for military trainers; areas exhibiting lower fire danger can remain open to a wider range of training activities. To prioritize pre-suppression actions, we employed a values-at-risk approach using vulnerability assessments. Stakeholder interviews identified resources and assessed their value to produce a ranking thereof. Stakeholders included military trainers, the fire department, natural resources, and others. Each resource was assigned a sensitivity ranking, which was then combined with an exposure ranking based on fire frequency, cheatgrass, and ignition sources. This composite produced a vulnerability map, allowing for the design and prioritization of fuelbreaks. We also include various strategies both for fuelbreak installation using of native species, as well as strategies for post-fire restoration.

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Historic Quaking Aspen Fire Regimes in Utah (USA) Forests

Stanley Kitchen, US Forest Service, Rocky Mountain Research Station

Co-authors: Emily K Heyerdahl, Peter M Brown

Quaking aspen (*Populus tremuloides*) is the most widely distributed tree species in North America. In the Intermountain West, aspen occurs across a broad range in elevation and is found in relatively pure stands and in association with various conifer species. Reproduction is primarily asexual (root suckering) resulting in long-lived, spatially-stable clones that benefit from periodic disturbance. Our objective was to characterize historic aspen fire regimes in Utah, a state with abundant aspen across a broad range of forest types. We extracted fire-scar and tree-recruitment data for 122 plots (aspen present) from 11 sites in which plot grids were designed to span a broad range in elevation and vegetation type (299 total plots). Aspen plot elevation ranged from 2340 to 3204 m for southern sites and from 2255 to 3172 m for northern sites. Based upon pre-Euro-American (1860) reconstructions, the proportions of study plots that were aspen- (≥ 50 percent stem density) versus conifer-dominated were approximately equal across all sites. Plot evidence of non-lethal, surface fires in the form of annually-dated fire scars (on conifers) was sufficient to estimate mean fire intervals for 19 plots. Estimates ranged from 7 to 109 years with a mean of 32.4 years (1650-1900). We inferred fire severity using criteria that took into account the presence (or absence) of fire scars and recruitment cohorts and tree mortality patterns. Plots were classified as 10 percent low-, 25 percent mixed- and 20 percent high-severity, with 45 percent unclassified. Results suggest that historically, aspen in Utah persisted in both aspen- and conifer-dominated stands, the composition and dynamics of which varied in response to temporal and spatial variation in fire regime parameters.

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Historical Mountain Big Sagebrush Fire Frequency from Fire-Scarred Trees: A Multi-site Analysis for Utah and Eastern Nevada

Stanley Kitchen, US Forest Service, Rocky Mountain Research Station

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Knowledge of past fire regimes associated with mountain big sagebrush (MBS) communities is inadequate for science-based land management that requires assessment of departure from historical conditions. Widely used estimates of MBS fire frequency are based upon studies using fire-scarred proxy trees located at forest/shrubland ecotones. These studies fail to adequately address questions of fire behavior across plant community boundaries or independent estimates of post-fire MBS recovery. We developed 71 fire chronologies from 190 fire-scarred trees located within or in close proximity to MBS communities at 10 sites in the eastern Great Basin, upper Colorado Plateau and intervening highlands. Average chronology length was 246 years. Mean fire interval ranged from 7.8 to 144.5 years. Mean, minimum and maximum fire-free intervals were evaluated based upon spatial relationship of fire-scarred trees to study MBS communities and were compared to documented MBS post-fire recovery rates. Within sites, fire frequencies were mostly similar for shrub-dominated, ecotonal and tree-dominated chronologies, suggesting that, in spite of shifts in fuel structure, forest-shrubland ecotones were relatively porous to surface fire spread. Conversely, high fire-frequency chronologies associated with some landscapes were not consistent with the fire-free intervals required for full MBS recovery and dominance, inferring that either fires burned in patchy, incomplete patterns or that MBS was historically less abundant (or absent), or both. Hence, both reconstructed fire regimes and vegetation successional dynamics must be considered when comparing historical and modern MSB responses to fire.

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Fire Disturbance Effects on Snow-Water Resources

Jordan Maxwell, PhD Student, Brigham Young University

Snowpack constitutes a large percentage of available water resources within the rocky intermountain regions of the west. It has been well established in the literature that dense conifer vegetation can reduce total snow depth and snow-water equivalence (SWE) by at least 60%. Forest fires at high elevation have the potential of defoliating large swaths of land, thus reducing interception and sublimation of snow on vegetation, and potentially increasing total water yields. In the Twitchell Canyon fire in the Tushar mountains near Beaver, Utah, sites were selected across a gradient of fire severity with sites placed in intact, mid-mortality, high-mortality, and open meadow sites. Snow depth and SWE were taken with a U.S. Federal snow sampler at peak snow pack at each site. A significant correlation was found between fire severity and SWE in each paired site. These findings help to confirm previous studies showing an increase of snow-water resources in a high elevation post-fire environment.

Great Basin Fire Science Exchange

Eugenie MontBlanc, The Great Basin Fire Science Exchange Coordinator, University of Nevada

The Great Basin Fire Science Exchange connects land 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 15 regional Fire Science Exchanges funded by the Joint Fire Science Program. The project works to:

1. Provide a forum for identification of fire, fuels, and post-fire vegetation management technical needs;
2. Develop and synthesize the information and technical tools to meet these needs;
3. Provide the information and technical tools through preferred venues;
4. Develop direct lines of communication between scientists and 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 and leads to research contacts, and we expect research scientists to benefit by gaining new ideas and partnerships for research and by providing new methods of outreach for research results.

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Exploring Solutions to Pinyon and Juniper Infestations through Biomass Field Days

Mark Nelson, Utah State University Extension, Beaver County, Utah

Pinyon and Juniper trees are taking over the rangeland in the western U.S. Currently there are nearly 50 million acres of Pinyon/Juniper woodlands and more acres are being invaded each year. Since World War II, the Forest Service and BLM have worked hard to stop forest fires. These efforts have resulted in more extreme fires today because of all the available fuels. Thinning can reduce or even eliminate the catastrophic aspect of a fire. Proactive management can provide positive use of pinyon/juniper fuels while reducing fire suppression and restoration costs. Utilization of woody biomass generated from forest treatments can provide jobs, stimulate the local economy and ultimately reduce the cost of forest treatments. Southern Utah Biomass, a loosely knit organization of private individuals and government personnel has come together to promote development of harvesting and utilization of pinyon/ juniper. Since October 2010 three field days have been hosted in Southern Utah. Over \$7.5 million in equipment has been brought out to demonstrate and exhibit. 715 people from 18 states, Canada and China have attended these field days. The field days demonstrated different methods of harvesting the pinyon/juniper and looked at ways of adding value to the harvested trees. Leading experts in the woody biomass and forestry industry addressed the importance of restoring the woodlands and ways for industry and government to partner together to discuss the problem.

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Livestock Grazing: An Environmentally Friendly and Economical Solution to Maintaining Fire Breaks

Matt Palmer, County Director/Extension Associate, Utah State University Cooperative Extension, Sanpete, Utah
Co-author: Eric Thacker

Government Agencies for decades have utilized state and federal funds to clear trees and brush around homes and recreational property to reduce the risk of wildfire damage. In Utah many fire breaks in gamble oak dominated sites are difficult to maintain due to rough terrain, resprouting gamble oak and the increased production of fine fuels following brush removal. These sites also tend to fill in and become thicker than pretreatment conditions leaving the area more vulnerable to fire than before. Some fuel break maintenance options include herbicides and or mechanical brush removal. Both of these methods require investments of time and money to maintain. These methods use large quantities of fossil fuel and or pesticides that can be expensive and harmful to the environment. The financial burden can become difficult for landowners when

public funding sources dry up. Livestock grazing is a method capable of maintaining fuel breaks. With some initial investments in fencing and livestock watering points, land owners can receive income from livestock grazing fees instead of the burdensome annual fuel break maintenance expenses. Our project demonstrates the potential effectiveness of grazing as an economically and ecologically sustainable option to maintain fuel breaks in oak woodlands.

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Effectiveness of Managing Cheatgrass and Other Fine Fuels in Non-Native Dominated Sagebrush Ecological Sites

David Pilliod, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center

Co-authors: Susan K. McIlroy, Douglas J. Shinneman, Robert S. Arkle, Nancy F. Glenn, Martha M. Brabec, Matthew J. Germino, and Marie-Anne de Graaff

Managing fire risk by reducing nonnative plants and restoring native plant communities is paramount to habitat conservation and implementing mandates such as Secretarial Order (3336) for Rangeland Fire Prevention, Management and Restoration in the western United States. Nowhere will this effort be more challenging than in the low precipitation (<8-10 inch) areas where repeated fires have resulted in conversion of big sagebrush communities to nonnative annual grasses and forbs. To evaluate potential restoration actions in these dry sites, we treated 48 1-ha experimental plots in nonnative plant-dominated communities located within three large replicate blocks with a full-factorial, completely randomized combination of fuel reduction/native plant restoration treatments: mowing, mowing + herbicide, herbicide application, and control (no treatment), with half of all plots seeded with native species. We also out-planted big sagebrush seedlings in some plots the growing season following seeding. Preliminary results suggest that treatment effects on fuels either disappear within the first year, or are often overshadowed by effects of inter-annual variability in precipitation. Seeding of native species was mostly unsuccessful, and out-planted sagebrush seedlings survived for a limited duration during the growing season, likely due to drought conditions. Survival probabilities for sagebrush seedlings did increase with mowing, except when followed by seeding, probably because the soil disturbance from the minimum-till drill led to less bare ground cover. Treatments had no significant effects on soil C decomposition or N mineralization rates. Thus, changes in soil nutrients were unlikely to explain observed treatment effects, or the lack thereof.

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Extreme 2014 Fire Season in California: A Glimpse into Future?

Simon Wang, Assistant Director, Utah Climate Center

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Fire in northern California during 2014 was the second largest in terms of burned areas since 1996. An increase in fire risk in California is attributable to human-induced climate change. To evaluate the severity of fires in 2014, satellite merged data of burned area from the fourth generation of the Global Fire Emissions Database was analyzed. The Keetch–Byram Drought index (KBDI) was included as well. The KBDI is computed with both the observational and simulated daily precipitation and maximum surface temperature. Projections for the western United States did show a steady increase of the fire risk based solely upon the KBDI. Year 2014 appears to be a turning point indicative of an accelerated increase in

extreme fire risk. The pace of increasing extreme fire risk has accelerated since the early 21st century and will surpass the range of natural climate variability. Observations show much faster increases of the KBDI and extreme fire risk measures

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Understanding Fuel Loadings in Healthy and Degraded Wyoming Big Sagebrush Ecological Sites Using a Fuels Database Tool

Justin Welty, Land Treatment Digital Library Project Coordinator, U.S. Geological Survey

Co-authors: Douglas J. Shinneman, David S. Pilliod, Robert S. Arkle, Nancy Glenn, Susan K. McIlroy

Sagebrush shrublands in the Great Basin are highly influenced by non-native plants that alter successional trajectories, suppress native species, and promote frequent wildfire. Fine-fuel loadings created by nonnative annual grasses and forbs can be highly variable through space and time, which can increase uncertainty when predicting fire risk and behavior. We sampled >2,500 subplots in southwestern Idaho over three years to estimate percent cover, vegetation height, and fuel loadings. These data along with elevation, precipitation, temperature, and soil information were entered into a newly developed fuels database tool. The tool is designed to assist land managers in estimating fuel loadings across an invasion gradient, ranging from intact sagebrush to nonnative-dominated communities. Users can query the data using vegetation cover, vegetation height, and specific environmental variables (e.g., elevation, precipitation, temperature, soil surface texture, and ecological site) and return fuel loading data that match query parameters. Queried database output also includes point-based photos, which can be used to identify and refine areas that best match the current ground conditions. Results can be exported to Excel or summarized in Word reports that can be taken into the field to aid ground-based estimates of fuel loadings. With additional fuels data input from users, the Fuels Project Database has the potential to be a powerful tool to assist land managers in making quick and accurate fuel loading estimates throughout a wide range of sagebrush shrubland conditions.

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Biological Soil Crust Effect on Restoration Grasses and Forbs Establishment Under Different Restoration Seeding Methods when Drilled, Minimum Till Drilled, and Broadcast

Hilary Whitcomb, PhD student at Utah State University, Ecology Center, Department of Environment and Society

Biological soil crusts (BSC) are an important ecological component of post-wildfire restorations. They can be classified into narrow or broad successional groups that have different impacts on plant available water, nutrients, and seed penetration. However, BSC successional groups have been poorly studied in semi-arid Great Basin restoration projects. We designed a greenhouse study to determine seed drilling interaction with five BSC groups (very little crust development [M1], early cyanobacteria [M2], mid-cyanobacteria [M3], diverse moss/lichen [M4], and tall-moss mats found predominantly under shrubs [M5]) on the invasive cheatgrass *Bromus tectorum* and common restoration species (bluebunch wheatgrass *Pseudoroegneria spicata*, bottlebrush squirreltail *Elymus elymoides*, needle-and-thread grass *Hesperostipa comata*, indian ricegrass *Achnatherum hymenoides*, western yarrow *Acchilea millefolium* L. var. *occidentalis*, and gooseberry globemallow *Sphaeralcea grossulariifolia*). Two pots of each group were range or minimum-till “drilled”

(using an auger) or broadcast, then singed with a heat lamp to simulate a light burn. BSC development and seeding treatment had significant effects on plant germination and fitness. Intact crust decreased cheatgrass germination while drilling improved its germination and fitness. Minimum-till drilling generally supported the best germination and fitness in all species. Range drilling and broadcast seeding were often surprisingly similar in their effect on grasses. Germination and fitness for both forbs were greater when broadcast compared to range drilling. More developed BSC supported greater germination and fitness across native species. Tall-moss often supported the fittest plants, but tended to have lower germination rates. Minimum-till drilling often resulted in lessened BSC group effect (e.g. no height difference in M2-M4) while range drilling tended to accentuate BSC group effects (e.g. taller plants with more developed BSC). Overall this study suggests interaction between BSC and seeding type may result in different outcomes for common restoration species. Field studies are recommended.

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The Effect of Large Fire on Aspen Recruitment

Trenton Wilde, Utah State University, Associate Professor, Millard County Extension

Aspen (*Populus tremuloides*) is an important part of forests in the western U.S. In contrast to conifers, aspen stands have a diverse understory of vegetation beneficial to wildlife and numerous other organisms. Fire is important to seral aspen, because fire is a major catalyst for initiating new aspen growth in seral stands. Due to the fire suppression strategies of the last century, many seral aspen stands have become overgrown with conifers choking out the aspen. Most efforts to restore fire to the landscape have been limited to small treatment areas. Wildlife and cattle are attracted to burn areas because of the lush, palatable vegetation which is initiated after a fire. The 2000 Oldroyd Fire- a 1329 acre managed fire in central Utah, experienced complete clone failure due to grazing. It was hypothesized that larger treatment areas would lower grazing pressure on vulnerable aspen shoots resulting in better aspen recruitment. Aspen recruitment areas on the 1996 Pole Creek Fire- a 7113 acre wildfire twenty miles west of the Oldroyd Fire, were identified and mapped on the ground using GPS technology. Geographic information system software was used to identify and quantify potential aspen recruitment areas through the use of pre-fire aerial photography. The resulting data revealed that 71% of the potential aspen recruitment area of the large fire had achieved aspen recruitment. These results indicate a significant correlation between larger disturbance areas and increased aspen recruitment.

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