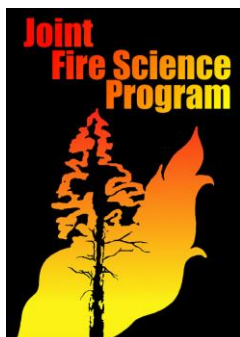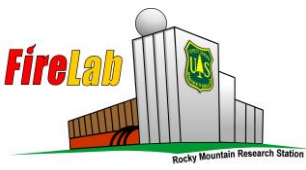# Snowbird Resort, Utah
14 – 17 November 2011

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Interagency Fuels Management Committee

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Interior West Fire Ecology Conference
Challenges and Opportunities in a Changing World
Monday, November 14

Time	Event
0830 – 1200	Workshop 1: LANDFIRE Wildland Fire Assessment Tool (WFAT) – Wasatch Room
	Workshop 2: Fuel Characteristic Classification System (FCCS), Consume, Fuels Photo Series, Pile Calculator – Magpie Room
1200 – 1330	LUNCH
1330 – 1700	Workshop 3: LANDFIRE Fire Regime Condition Class (FRCC) assessment– Wasatch Room
	Workshop 4: Behave Plus– Magpie Room
0830 – 1700	Registration

Tuesday Morning, November 15

Time	Talk Number	Speaker	Title
OPENING PLENARY – Ballroom 3			
0830 – 0840		Brian Oswald	Conference welcome
0840 – 0910	001	Tom Quigley	Cohesive Strategy: Potential Changes in Fire Management Direction
0915 – 0945	002	Steven Ellis	Fire in the Great Basin – The Nature of Change
0950 – 1020	003	Jeremy Littell	Projected Changes in Climate in the Interior West and Implications for Area Burned by Fire
1020 - 1050			BREAK – Ballroom 2
1050 – 1120	004	Robin Tausch	Vegetation Change in the Great Basin over Time
1125 – 1155	005	Penny Morgan	Preparing Wildland Fire Professionals for a Changing Future
1200 - 1330			LUNCH SAFE Meeting Poster Set-up – Ballroom 1

Tuesday Afternoon, November 15

Time	Talk Number	Speaker	Title
Session 1: Black-backed Woodpecker Special Session – Wasatch Room			
1330 – 1350	101	Monica Bond	Post-fire Habitat Use by the Black-backed Woodpecker
1350 – 1410	101	Chad Hanson	Post-fire Habitat Availability and its Implications for the Black-backed Woodpecker
1410 – 1430	101	Dennis Odion	Implications of Forest Thinning for the Habitat of the Black-backed Woodpecker
1430 – 1450		Panel Discussion	
1510 - 1540		BREAK – Ballroom 2	
Session 2: Fire and Invasives – Wasatch Room			
1540 - 1600	201	Jeanne Chambers	Factors that Determine Resistance to Cheatgrass (*Bromus tectorum*) in Sagebrush and Pinyon and Juniper Dominated Ecosystems
1600 - 1620	202	Cheryl Decker	Fighting Cheatgrass Instead of Fire in Zion National Park—Summary of Treatment Effectiveness and Lessons Learned
1620 – 1640	203	Allissa Corrow	Simulating Effects of Cheatgrass Invasion and Climate Changes on Wildfire Patterns in an Old-growth Western Juniper Ecosystem: Implications for Management and Restoration
1640 - 1700	204	Kirk Davies	Fire Management for Preventing and Controlling Exotic Annual Grass Invasions
1730 - 1900		POSTER SESSION and NO-HOST SOCIAL – Ballrooms 1 and 2	

Tuesday Afternoon, November 15

Time	Talk Number	Speaker	Title
Session 3: Post-disturbance Fuel and Fire Modeling Special Session – Superior Room			
1330 – 1350	301	Jeffery Hicke	Effects of Beetle-caused Mortality on Wildfire
1350 – 1410	302	Garrett Meigs	Mapping Disturbance Effects on Forest Fuels: Implications for Insect-Fire Interactions
1410 – 1430	303	Dan Donato	Assessing Forest Fuels After Bark Beetle Outbreaks and Other Disturbances: What Can Fire Models Tell Us?
1430 – 1450	304	Morris Johnson	Effects of Logging on Fuels and Fire Behavior Following a Windstorm
1450 – 1510	305	Russell Parsons	Impacts of Mountain Pine Beetle Outbreaks on Coupled Fire/Vegetation/Atmosphere Interactions in Lodgepole Pine Stands using FIRETEC
1510 – 1540			BREAK – Ballroom 2
1540 – 1600	306	Chad Hoffman	The Use of WFDS to Quantify Crown Fire Hazard Following Bark Beetle-caused Mortality in Lodgepole Pine Forests
1600 – 1620	307	Michael Jenkins	The Influence of Fuel Moisture and Monoterpenes on the Flammability of Conifer Fuels
1620 – 1640	308	Matt Jolly	Relationship Between Foliar Moisture, Leaf Chemistry and Ignitability of *Pinus contorta* Needles during the Early Stages of Mountain Pine Beetle Attack
1640 - 1700		Travis Woolley	Session summary
1730 – 1900			POSTER SESSION and NO-HOST SOCIAL – Ballrooms 1 and 2

Tuesday Afternoon, November 15

Time	Talk Number	Speaker	Title
Session 4: Fire and Interior West Ecosystems – Magpie Room			
1330 - 1350	401	Jon Bates	Juniper Debris Burning and Vegetation Recovery
1350 - 1410	402	Kerry Kemp	Multiple Disturbance Interactions and their Effect on Understory Response after Fire in Subalpine Forests of Northern Colorado
1410 – 1430	403	Jessica Hudec	Fuel Variability Following Wildfire in Forests with Mixed Severity Fire Regimes, Cascade Range, USA
1430 – 1450	404	Katie Johnson	A Multifaceted Analysis of Fire Monitoring Handbook Data from Bryce Canyon National Park
1450 - 1510	405	Jon Bates	Herbaceous Response to Fire in Wyoming Big Sagebrush Associations
1510 – 1540			BREAK – Ballroom 2
1540 – 1600	406	Michael Battaglia	Tree Seedling Germination and Establishment in Masticated Forest Stands, Colorado
1600 – 1620	407	Casey Teske	Characterizing Fire-on-Fire Interactions in Three Large Wilderness Areas Using the Monitoring Trends in Burn Severity (MTBS) Fire Perimeter Data
1620 – 1640	408	Marty Alexander	What kind of fire behavior is required to open serotinous cones of jack pine and lodgepole pine?
1640 - 1700			
1730 – 1900			POSTER SESSION and NO HOST SOCIAL – Ballrooms 1 and 2

Wednesday Morning, November 16

Time	Talk Number	Speaker	Title
Session 5: Post-fire Erosion Special Session Wasatch Room			
0800 – 0840	501	Jason Williams	Hydrologic and Erosional Impacts Associated with an Increased Role of Wildland Fire on Western Rangelands
0840 – 0900	502	Vic Etyemezian	Wind Erosion Measurements up to Three Years after Fire
0900 – 0920	503	Matt Germino	Surface Conditions Affecting Post-fire Wind Erosion in Cold Desert
0920 – 0940	504	Jan Eitel	Surface Roughness Effects on Concentrated Flow Erosion Processes in Rangelands Pre- and Post-fire
0940 – 1000	505	Joel Sankey	Quantifying Biogeomorphic Response to Fire at Micro-biome Scales
1000 – 1030			BREAK – Ballroom 2
1030 – 1050	506	Natalie Wagenbrenner	Measuring and Modeling Dust Emissions from Soils Burned by Wildfire
1050 – 1110	507	Nancy Glenn	Remote Sensing of Post-fire Conditions in Sage-steppe
1110 – 1130	508	Beth Newingham	Comparing the Effects of Post-fire Seeding Techniques on Soil Erosion in a Dryland Ecosystem
1130 – 1200	509	Mark Miller	Post-fire Rehabilitation Treatments and Wind Erosion in Low-elevation Rangelands – Lessons from the Milford Flat Fire
1200 - 1330			AFE Members Meeting and Luncheon – Ballrooms 2 and 3

Wednesday Morning, November 16

Time	Talk Number	Speaker	Title
			Session 6: SageSTEP Special Session – Superior Room
0750 – 0800	601	Jim McIver	Introduction
0800 – 0820	602	David Pyke	Stress in Fire-Prone Sagebrush Steppe and Resistance to Cheatgrass Invasion
0820 – 0840	603	Rick Miller	Short-term vegetation Response to Piñon and Juniper Removal in Sagebrush-Steppe
0840 – 0900	604	Bruce Roundy	Effects of Fire and Fuel Treatments on Soil Water Availability in Sagebrush Communities
0900 – 0920	605	April Hulet	Characterizing Pinyon-Juniper Woodlands Post Fuel-Reduction Treatments Using High-Resolution Imagery
0920 – 0940	606	Nathan Cline	Germination Prediction from Soil Moisture and Temperature in the Great Basin
0940 – 1000	607	Jason Williams	Runoff and Erosion Responses on Burned and Unburned Sagebrush Steppe and Wooded Shrublands in the Great Basin, USA
1000 – 1030			BREAK – Ballroom 2
1030 – 1050	608	Kert Young	Mechanically Shredding Utah Juniper and Soil Environment Characteristics
1050 – 1110	609	Steve Knick	Short-term Response by Bird Communities to Pinyon-Juniper Removal by Prescribed Fire
1110 – 1130	610	Jim McIver	Butterfly Response to Sagebrush Steppe Fire and Fire Surrogate Treatments: Unintended Consequences?
1130 – 1150	611	Kim Rollins	Measuring the Economic Value of Fuel Treatments on Great Basin Rangelands
1150 – 1200		Jim McIver	Summary
1200 - 1330			AFE Members Meeting and Luncheon – Ballrooms 2 and 3

Wednesday Morning, November 16

Time	Talk Number	Speaker	Title
			Session 7: Fire Trek: The Next Generation Special Session – Magpie Room
0800 – 0820	701	Brooke Cassell	Potential Impacts of Climate Change on Fire Regimes in the Sierra de Manantlan Biosphere Reserve, Mexico
0820 – 0840	702	Kevin Krasnow	Wildfire, Management, and Regeneration of Quaking Aspen (*Populus tremuloides*) in the Sierra Nevada and Glass Mountains, California, USA
0840 – 0900	703	Lauren Poulos	Prescribed Fire and its Interactions with the Invasive Bunchgrass, *Brachypodium sylvaticum*
0900 – 0920	704	Amber Shanklin	Rehabilitation of Slash Piles in Colorado
0920 – 0940	705	Garren M. Andrews	Post-fire Response Following Mixed-severity Fires in Redwood/Douglas-fir Forests
0940 – 1000	706	Sharon Hood	How does Fire and Water Stress Affect Tree Resistance to Bark Beetles?
1000 – 1030			BREAK – Ballroom 2
1030 – 1050	707	Anna Morgante	Incorporating Spotting into a Simple Fire Perimeter Model
1050 – 1110	708	Karin Riley	The Relationship of Large Fire Occurrence to Drought and Fire Danger Indices in the US West using Downscaled Weather Data
1110 – 1130	709	Chris Dunn	Comparison of Forest Structure and Carbon Dynamics between Intensively Managed and Unmanaged Forest Environments Following Fire Disturbance
1130 – 1200	710	Garrett Meigs	Pyrodiversity in Pacific Northwest Forests: a Photographic Journey Through Space and Time
1200 - 1330			AFE Members Meeting and Luncheon – Ballrooms 2 and 3

Wednesday Afternoon, November 16

Time	Talk Number	Speaker	Title
			Session 8: Climate Change and Carbon Dynamics – Wasatch Room
1330 - 1350	801	Andrea Brunelle	Holocene Fire Disturbance from South-central Utah
1350 - 1410	802	Rachel Loehman	Modeling Effects of Climate Change and Fire Management on Western White Pine (*Pinus monticola*) in the northern Rocky Mountains, USA
1410 – 1430	803	Jessica Haas	And the flames went higher? Future Trends in Burn Probabilities and Flame Lengths under Changing Climates
1430 – 1450	804	Tom DeMeo	Anticipated Effects of Water Balance Deficit on Fire Regime Class at Mid-Century In the Blue Mountains, Oregon
1450 - 1510			
1510 – 1540			BREAK – Ballroom 2
1540 – 1600	806	Chris Dicus	Simulated Carbon Dynamics in Post-fire Successional Pathways of the Wasatch Mountains, Utah
1600 – 1620	807	Chris Dunn	Incorporating Snag Dynamics into Estimates of Post-fire Carbon Emissions from Dead Biological Legacies
1620 – 1640	808	Kevin Osborne	Impacts of Alternative Landscape-level Fuel Management Strategies on Short-term Carbon Emissions and Long-term Carbon Storage
1640 - 1700	809	Karin Riley	Risk-based Estimates of Terrestrial Carbon Storage and Wildfire Emissions for the Conterminous US
1830 – 2100			BANQUET and AWARDS – Ballrooms 2 and 3 006 - Stan Kitchen – Living with Cheatgrass

Wednesday Afternoon, November 16

Time	Talk Number	Speaker	Title
Session 9: Fire and Resource Management 1 – Superior Room			
1330 – 1350	901	Alison Dean	Coyote Hills: An Adaptive Management Case Study
1350 – 1410	902	Susan Hummel	Science communication networks: the case of fish and fire
1410 – 1430	903	Laine Christman	The Expected Value of Wildfire Potential Information: A Discrete-Space Location-Allocation Problem for Fire Suppression Resources
1430 – 1450	904	Emily Comfort	Fire Regimes, Forest Change and Restoration of Forested Landscapes in the Middle Applegate Watershed, Oregon
1450 – 1510	905	Joe Scott	Assessing the Potential Impact of Wildfires Managed for Multiple Objectives Using the FSIM Large Fire Simulator
1510 - 1540			BREAK – Ballroom 2
1540 - 1600	906	LaWen Hollingsworth	Application and Utility of a Prototype Fire Perimeter Database for Wildfire Operations, Project Planning, and Research
1600 - 1620	907	Morgan Pence	Spatial Fire Management Planning within WFDSS
1620 - 1640	908	Susan Hummel	National fire severity classes related to tree mortality measured two years post-burn
1640 - 1700	909	Marty Alexander	On the Value of Wildland Fire Behavior Case Studies
1830 – 2100			BANQUET and AWARDS – Ballrooms 2 and 3 006 - Stan Kitchen – Living with Cheatgrass

Wednesday Afternoon, November 16

Time	Talk Number	Speaker	Title
Session 10: Mapping, Modeling and Monitoring – Magpie Room			
1330 - 1350	1001	Peter Roohr	The Availability of NOAA Climate Services and Support for Fighting Wildfires
1350 - 1410	1002	Joe Scott	Techniques for Landscape-scale Assessment of Potential Wildfire Behavior
1410 – 1430	1003	Steve Barrett	Fire Regime Condition Class: Concepts, Methods, and Applications
1430 – 1450	1004	Greg Dillon	Both Topography and Climate Affected Burn Severity in Forests and Woodlands of the Western US, 1984 to 2006
1450 - 1510	1005	Yi Qi	Remote Monitoring of Sagebrush and Gambel Oak Live Fuel Moisture using Soil Moisture and Remote Sensing Proxies
1510 – 1540			BREAK – Ballroom 2
1540 – 1600	1006	Julie Gilbertson-Day	Sensitivity of Fire Behavior Metrics to Change in Fuel Data Resolution and Implications for Landscape Wildfire Risk Analysis
1600 – 1620	1007	Matt Jolly	Apparent Changes in Conifer Foliar Moisture are Driven by Seasonal Dry Weight Allocation
1620 – 1640	1008	Carl Seielstad	Frontiers in Fuels Science: Using Laser Scanners to Re-invent Fuels Characterization
1640 - 1700	1009	Ron Steffens	Seasonal fuel moisture monitoring and climate trends: a 20 year assessment from Grand Teton National Park
1830 – 2100			BANQUET and AWARDS – Ballrooms 2 and 3 006 - Stan Kitchen – Living with Cheatgrass

Thursday Morning, November 17

Time	Talk Number	Speaker	Title
Session 11: Fuels Management Techniques – Wasatch Room			
0800 – 0820	1101	Kate Cueno	Initial Results Following Thinning and Chipping of Ponderosa Pine
0820 – 0840	1102	Michael Battaglia	Integrated Fuel Treatments from the Site to the Landscape: Restoration of Northern Rocky Mountain Moist Forests
0840 – 0900	1103	Jesse Kreye	Effects of Mastication on Fire Behavior and Fire Effects in Litter-Dominated Fuelbeds
0900 – 0920	1104	Jonathan Large	Ignition Characteristics of Mulched Fuels
0920 – 0940	1105	Bob Keane	Scaling Surface and Canopy Fuels in the Northern Rocky Mountains, USA
0940 – 1000	1106	Bob Keane	Describing Spatial Variability of Surface and Canopy Fuels in the Northern Rocky Mountains, USA
1000 - 1020	1107	Michael Battaglia	A Comprehensive Guide to Fuels Management Practices for Ponderosa Pine/ Dry Mixed Conifer Forests: Eastern Cascades, Klamath/Siskiyou, Northern Rockies, and Utah
1020 - 1100			BREAK – Ballroom 2
Closing Plenary – Ballroom 3			
1100 – 1130	007	Dave Thomas	Metaphors Fire Ecologists Use: Observations of An Amateur Anthropologist at the Interior West Fire Ecology Conference
1130 – 1140		Louisa Evers	Closing Remarks

Thursday Morning, November 17

Time	Talk Number	Speaker	Title
Session 12: Socioeconomic Issues and Fire – Superior Room			
0800 – 0820	1201	Kim Rollins	Ecology and Economics of Fire: Integrated Models
0820 – 0840	1202	Kyle Stetler	The Effects of Wildfire and Environmental Amenities on Property Values in Northwest Montana
0840 – 0900	1203	Tim Ingalsbee	Smoke Signals: New Messages and Policies to Nurture Greater Public Tolerance for Forest Fire Smoke
0900 – 0920	1204	Rachael Houtman	Letting Wildfires Burn
0920 – 0940	1205	Kim Ernstrom	Opportunities for Change and Influence within the Framework of Wildland Fire
0940 – 1000	1206	Allen Rowley	Line Officer Philosophy and Intent: Decision-making on a Large Fire
1000 - 1020	1207	Amanda Rau	Anthropogenic Fire in Designated Wilderness on the Deschutes National Forest
1020 - 1100			BREAK – Ballroom 2
Closing Plenary – Ballroom 3			
1100 – 1130	007	Dave Thomas	Metaphors Fire Ecologists Use: Observations of An Amateur Anthropologist at the Interior West Fire Ecology Conference
1130 – 1140		Louisa Evers	Closing Remarks

Thursday Morning, November 17

Time	Talk Number	Speaker	Title
			Session 13: Fire and Resource Management 2 – Magpie Room
0800 – 0820	1301	Brad Washa	Hazardous Fuels Treatment Effectiveness on Utah BLM Lands
0820 – 0840	1302	David Pilliod	Spring-ignited Prescribed Fires Reduce the Severity of Subsequent Wildfire in Central Idaho
0840 – 0900	1303	Linda Chappell	After the Burn: Twitchell Canyon Wildfire 2011 Post-fire Vegetation Response
0900 – 0920	1304	Susan Prichard	Landscape Analysis of Fuel Treatments and Wildfire Severity in North-central Washington State
0920 – 0940	1305	Travis Woolley	Lodgepole Pine Forests Following Mountain Pine Beetle Epidemics: A Chronosequence of Fuels and Potential Fire Behavior for South-central Oregon.
0940 – 1000	1306	Brian Oswald	Addressing Highly Underestimated Risks of Wildland Fire in Rural–urban Interface Areas in The Netherlands: a Collaborative Effort between the Dutch Government and Stephen F. Austin State University
1000 - 1020	1307	Brian Oswald	Drought and Fire in Texas 2011
1020 - 1100			BREAK – Ballroom 2
			Closing Plenary – Ballroom 3
1100 – 1130	007	Dave Thomas	Metaphors Fire Ecologists Use: Observations of An Amateur Anthropologist at the Interior West Fire Ecology Conference
1130 – 1140		Louisa Evers	Closing Remarks

002   Abbey, Bob* presented by **Steven Ellis**

Fire in the Great Basin – The Nature of Change

Abstract: Fire in our day is often painted by mainstream media and others as a destructive, catastrophic force, threatening natural resources, communities, and human life itself. Yet the truth is that Western landscapes evolved with fire and fire remains essential to the health of the Interior West. Today, fire and fuels, in tandem, continue to be among the most powerful forces in shaping the future health and productivity of the Great Basin, especially in light of connected and formidable challenges and issues: Climate change; the relentless spread of invasive and encroaching species; the role of livestock grazing; the loss of sagebrush habitat; and the overall health of western rangelands. Clearly, the Great Basin is changing in ways that aren't always predictable or to our liking. As the agency with major rangeland stewardship responsibilities in the Great Basin, the Bureau of Land Management will have a crucial say in the region's future. At the center of those responsibilities is fire, and how it will shape the look, feel and future of the changing Interior West.

*Bureau of Land Management, National Office, Washington, DC

909   **Alexander, Martin E.[1]** and D.A. Thomas[2]

On the Value of Wildland Fire Behavior Case Studies

Abstract: The preparation of wildland fire behavior studies represents both an opportunity and a challenge to the wildland fire community in the future. While the continuance of basic research into fire fundamentals is essential to gaining a complete understanding of the physical processes involved in wildland fire dynamics, scientific knowledge alone will not be enough. There is still an overriding need to bolster efforts in observing free-burning wildland fire behavior and completing the necessary case study documentation. Such an effort should be regarded as part and parcel of adaptive management. Case study knowledge will prove a useful compliment to fire behavior modeling and experience judgment when it comes to appraising potential wildland fire behavior. This presentation will provide a summary of the authors' feelings on the value of case studies of wildland fire behavior based in part on several articles published in Fire Management Today between 2003 and 2010, copies of which are available for downloading from the FRAMES Applied Wildland Fire Behavior Research & Development subject area website (http://frames.nbii.gov/applied_fire_behavior). This presentation is a contribution of Joint Fire Science Program Project JFSP 09-S-03-1; for information on this project visit the project website (http://www.fs.fed.us/wwetac/projects/alexander.html). A copy of the powerpoint associated with this presentation will be posted on both of these websites following the conference.

[1]University of Alberta, Edmonton; [2]Renoveling, Ogden, UT

408 **Alexander, Martin E.**[*]

What kind of fire behavior is required to open serotinous cones of jack pine and lodgepole pine?

Abstract: A methodology has been developed for defining the threshold conditions required for the opening of serotinous cones and viable seed release in jack pine (*Pinus banksiana*) and lodgepole pine (*Pinus contorta* var. *latifolia*) forests on the basis of fireline intensity and in turn rate of fire spread and fuel consumption. The extent to impacts to the overstory canopy (i.e., crown scorching and flame defoliation) and the type of fire (i.e., low- to high-intensity surface, intermittent crown, and active crown) vary at any given fireline intensity level is principally a function of foliar moisture content, canopy base height, stand height, and canopy bulk density. The viability of the seed stored in serotinous cones of the two pine species drastically decreases once the flame front residence time at the ground level of an active crown fire in a stand exceeds approximately 50 seconds.

[*]University of Alberta, Edmonton

705 **Andrews, Garren M.**[*]

Post-fire Response Following Mixed-Severity Fires in Redwood/Douglas- fir Forests

Abstract: We investigated how fire severity impacts the survival and response (sprouting/seeding) of multiple species in the Santa Cruz Mountains of coastal California, including coast redwood (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*), tanoak (*Lithocarpus densiflorus*), and Pacific madrone(*Arbutus menziesii*). During August 2009 the Lockheed fire burned nearly 3,160 ha of mixed-conifer stands with variable severity. Data from 37 Continuous Forest Inventory (CFI) plots were collected immediately before and for 2 successive years following the 2009 Lockheed Fire. This research entails three objectives. First, we quantified post-fire mortality of trees that vary in species, size, and fire severity. Second, data was quantified for post-fire response (sprouting, seeding) of those four tree species in areas of varying fire severity. Third, we developed logistic regression models that predict post-fire mortality and response for each of the four species. Understanding the relationship between burn severity, mortality and regeneration can allow for better post-fire predictive services. This research can support forest managers in determining the best management practices to facilitate long-term sustainability and protection of environmental infrastructure within coast redwood/Douglas-fir forests.

[*]California Polytechnic State University, San Luis Obispo, CA

1003 **Barrett, Stephen**[1] and Doug Havlina[2]

Fire Regime Condition Class: Concepts, Methods, and Applications

Abstract: Fire Regime Condition Class (FRCC) assessments have been widely used for evaluating ecosystem status in many areas of the U.S. Since inception in the late 1990's, the method has been applied in multi-scale assessments in many facets of natural resource planning. For example, whereas initial FRCC mapping depicted coarse scale (1 km2 resolution) national trends, the process has since evolved to characterize landscapes, watersheds, and individual project areas to the stand scale. We used state-and-transition modeling to describe historical vegetation and fire regimes, which provided reference information related to landscape fire frequency, severity, and vegetation seral stage proportions. To

promote methodological consistency, we then developed a quantitative method based upon similarity indexing to compare historical versus current vegetation and fire regimes. This technique allows field and GIS users to consistently assess FRCC for fire management plans and related planning efforts. Current applications of FRCC data include project design, risk assessments, treatment prioritization, fire use decisions, and evaluation of ecosystem sustainability. Although FRCC does not represent a stand-alone risk or allocation tool, such assessments provide a consistent landscape metric that can complement other measures of ecological health and fire regime departure. At the national scale, the LANDFIRE mapping project provides downloadable FRCC and related GIS layers (30 m^2 resolution) as a refinement of the initial FRCC coarse scale map for the U.S. Although FRCC methodology and associated software have undergone several version changes over the past decade, the recent release of FRCC Guidebook Version 3.0 represents the most substantial refinement to date.

[1]National Interagency Fuels Technology Team, Kalispell, MT; [2]Bureau of Land Management, National Office, Boise, ID

401 **Bates, Jon**[*], Kirk Davies[*], Tony Svejcar[*], and Rory O'Connor[*]

Juniper debris burning and vegetation recovery

Abstract: Prescribed fire and mechanical cutting are the main methods used to remove western juniper and restore sagebrush-steppe in eastern Oregon. Mechanical treatments commonly prescribed leaving cut juniper to enhance establishment of seeded perennial grasses, retain nutrients, and reduce runoff and erosion. Disadvantages to leaving juniper debris is the increased fuel hazard, particularly the first 2-3 years post-treatment when most needles remain suspended on downed trees. Recently, efforts have shifted to removing juniper debris by burning from early fall through late spring to reduce potential fire hazards. This study evaluated the response of herbaceous vegetation and levels of juniper fuel reduction from burning in early fall, mid-winter, late-winter, and mid-spring in mountain big sagebrush plant communities. Early fall and mid spring burning were effective at removing cut juniper up to and exceeding 1000 hour fuel categories. Mid-winter and late spring burning consumed all 1 hour fuels, except those in contact with the ground surface, and small proportion of 10 hour fuels. Early fall and mid-spring burning killed a high proportion of perennial grasses (50-95%) and forbs (50-90%) located beneath cut juniper and in litter mats surrounding tree stumps. Mid-winter and late winter burning caused some mortality (0-50%) of perennial grasses beneath cut juniper and in litter mats surrounding tree stumps. Recovery of native herbaceous vegetation was faster in mid- and late winter burning treatments and there was little threat of invasive weeds becoming problematic compared to early fall and mid-spring burning.

[*]USDA Agricultural Research Service, Burns, OR

405 **Bates, Jon**[*], Kirk Davies[*], and Rory O'Connor[*]

Herbaceous response to fire in Wyoming big sagebrush associations

Abstract: We evaluated herbaceous recovery 8 to 10 years after prescribed fire and wildfire in three of the main Wyoming big sagebrush associations found in eastern Oregon (Bluebunch, Thurber's needlegrass, Thurber's needlegrass-Idaho fescue). Herbaceous response variables were canopy cover, productivity, and species diversity. Sagebrush was completely removed on the wildfire and was reduced by 95% on prescribed burns. Herbaceous cover increased on the

Thurber's needlegrass association as a result of increases in annual forbs and cheatgrass. Density of perennial grasses on the Thurber's needlegrass association was reduced by 92%. On Bluebunch and Thurber's needlegrass-Idaho fescue association's post-fire recovery was dominated by perennial bunchgrasses and native or nonnative annual forbs. The non-native forb that increased after fire was pale alyssum which may become problematic by inhibiting recovery of native species immediately after fire. Pre-fire herbaceous species composition was retained on the Bluebunch and Thurber's needlegrass-Idaho fescue associations. Species composition on the Thurber's needlegrass associations was profoundly altered from dominance by perennial grasses and forbs prior to fire to dominance by pale alyssum, longleaf-phlox, and cheatgrass after fire. The susceptibility of Wyoming big sagebrush plans associations to replacement by nonnative annuals is connected to the level of mortality of perennial grasses after fire. Wyoming big sagebrush Thurber's needlegrass and Thurber's needlegrass-Idaho fescue associations are likely the most susceptible to non-native annual replacement after wildfire or high intensity prescribed fires. Herbaceous composition is unlikely to be altered in Bluebunch wheatgrass associations by either wild or prescribed fire.

*USDA Agricultural Research Service, Burns, OR

406　**Battaglia, Michael[1]**, Katherine Cueno[2], Paula Fornwalt[1] and Charles Rhoades[1]

Tree seedling germination and establishment in masticated forest stands, Colorado

Abstract: In recent years, fire managers in the western U.S. have increased their use of mastication treatments – the on-site disposal of shrubs and small-diameter trees through chipping and shredding. Mastication is a relatively untested management practice that is now known to alter physical conditions of the forest floor over the short-term. The mulched woody material increases both the load and continuity of surface fuels, and creates a new forest floor layer that may act as a physical barrier to tree germination; however, it also helps to conserve soil moisture and moderate summer soil temperatures, thereby favoring germination. We established 18 pairs of untreated and masticated sites (treated between 2004 and 2006) across four forest types in Colorado. We hypothesize that mulch-free microsites within the masticated areas will provide favorable conditions for tree seedling germination and establishment due to the moderated soil moisture environment from adjacent mulch combined with the lack of a physical woody barrier. In summer 2011, we will inventory seedlings and measure the substrate cover and mulch depth in the surrounding 25 x 25 cm quadrats to examine the influence of environmental factors on seedling occurrence. Results from this study will help clarify the mechanisms that favor and discourage tree seedling germination and establishment in masticated areas and will provide management recommendations that emphasize how best to distribute mulch across treated sites.

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1107　**Battaglia, Michael[1]**, Terrie Jain[2], Han Han-Sup[3], and Russell Graham[2]

A comprehensive guide to fuels management practices for ponderosa pine/ dry mixed conifer forests: Eastern Cascades, Klamath/Siskiyou, Northern Rockies, and Utah

Abstract: This project developed an integrated synthesis that provides forest land managers with comprehensive, up-to-date knowledge on ecological values

and options for management of hazardous fuels within ponderosa pine / mixed conifer (PP/MC) forests. We focused on PP/MC forests that occur throughout the eastern Cascades, Klamath/Siskiyou, Northern Rockies, and Utah. There is substantial documentation on fire ecology and appropriate hazardous fuel management practices for pure ponderosa pine forests. The PP/MC forest type, however, is less well understood, and is typified by greater productivity, complex vertical and spatial structure, diverse species assemblages, and varied fire regimes. Practices borrowed from the pure ponderosa type may be inappropriate for the different conditions presented by the PP/MC forest type. In addition to performing a thorough scientific literature search to integrate up-to-date knowledge associated with fuels treatment within PP/MC forests we interviewed land managers from over 20 National Forests to better understand their needs and challenges in fuels management. With their input and feedback we focused on the literature that would be most useful to inform managers while planning, implementing, and evaluating fuels treatments. The Guide covers a variety of subjects including the ecology of PP/MC forests, vegetation and fuel dynamics, wildlife habitat, current conditions, implementation of fuel treatments, decision support tools, treatment longevity, economic analysis, and monitoring.

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101 **Bond, Monica[1]**

Post-fire Habitat Use by the Black-backed Woodpecker

Hanson, Chad[2]

Post-fire Habitat Availability and its Implications for the Black-backed Woodpecker

Odion, Dennis[3]

Implications of Forest Thinning for the Habitat of the Black-backed Woodpecker

Abstract: The Black-Backed Woodpecker as "Spotted Owl" of Post-Fire Forests. The Black-backed woodpecker is strongly associated with early successional burned forest habitat with high snag density. As an indicator of the status of this habitat and its biodiversity, the Black Backed Woodpecker has been described as the "spotted owl" of early successional forests. The conservation of this species therefore has significant implications for forest and fire management policies in Western forests. This special session will examine the growing body of research on the ecological value of post-fire forests for the Black-backed woodpecker and other species. It will feature presentations by three scientists involved in studying the woodpecker and its habitat—Dr. Chad Hanson (University of California, Davis); Monica Bond (Wild Nature Institute); and Dr. Dennis Odion (Southern Oregon University). Their presentations will address the following tropics: the ecological niche of the Black-backed woodpecker; the habitat needs of this species in relation to the amount of high-severity fire; the role of early successional burned forest habitat for other species in addition to the woodpecker; and the implication of fuel treatments on the post-fire habitat of the Black-backed woodpecker and other species.

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801 **Brunelle, Andrea[1]**, Jesse Morris[1], Steve Munson[2], and Mitch Power[1]

Holocene fire disturbance from south-central Utah

Abstract: Three 9000 year fire histories from the high elevation, spruce-fir dominated plateau forests in Utah provide information on the relative significance of ENSO (winter) and convective storm (summer) moisture on the fire regime in these regions. La Niña conditions alone do not appear to be the only driver of elevated fire frequency and large magnitude events on the sites we examined in south-central Utah. Because of the high elevation and incursions of moist 'monsoonally-derived moisture' during summer months, using winter precipitation is not an adequate predictor for fire in this region. Summer moisture and temperature conditions are important factors affecting fire occurrence. The strength and northern extent of the North American Monsoon is an important factor in regulating growing season moisture, fuel moisture conditions, and providing potential sources of ignition. Summer temperature influences fire season length and whether spring and fall precipitation arrive as rain or snow. As climate changes and ENSO and monsoonal patterns alter, understanding the relationship between climate drivers and fire across space and time will be very useful in managing these high elevation systems.

[1]University of Utah, Salt Lake City; [2]USDA Forest Service, Rocky Mountain Research Station, Ogden, UT

701 **Cassell, Brooke[1]**, Ernesto Alvarado[1], Diego Perez Salicrup[2], Enrique Jardel Palaez[3]

Potential impacts of climate change on fire regimes in the Sierra de Manantlan Biosphere Reserve, Mexico

Abstract: Fire has been attributed as one of the most influential factors in vegetation community and succession in the Sierra de Manantlán Biosphere Reserve in Jalisco and Colima, México. A mosaic of low, mixed and high severity fire regimes characterizes the topographically complex landscape with ecosystems ranging from mesophyllous mountain forest to higher elevation pine and oak forest. We are constructing a tree-ring master chronology and reconstructing a fire history from fire scarred trees at pine-dominated sites throughout the reserve. We are analyzing changes to the fire regime following establishment of the protected zone of the reserve and the impacts to vegetational successional patterns, habitat and impact on future fire severity. We will also examine climatic patterns and their relationship to fire occurrence and severity, thus allowing for inference about potential climate change impacts. This research will create a baseline of knowledge about the fire regime and historical range of variability in the biosphere reserve, facilitating scientifically informed land and fire management plans in the face of climate change.

[1]University of Washington, Seattle; [2]Universidad Nacional Autonoma de Mexico, Morelia, Michoacan; [3]Universidad de Guadalajara, Autlan, Jalisco

201 **Chambers, Jeanne[1]** and Bruce Roundy[2]

Factors that determine resistance to cheatgrass (*Bromus tectorum*) in sagebrush and pinyon and juniper dominated ecosystems

Abstract: *Bromus tectorum* or cheatgrass is an invasive annual that has altered fire regimes across millions of acres in the Great Basin. We conducted a series of studies over the elevational gradients that characterize these landscapes to

evaluate the abiotic and biotic factors influencing resistance of sagebrush and pinyon and juniper dominated ecosystems to *B. tectorum*. We examined the effects of fire, perennial herbaceous species and environmental characteristics on soil resource availability (nutrients and water) and establishment and reproduction of *B. tectorum*. Resistance to *B. tectorum* reflected its ecological amplitude, but was strongly influenced by resource availability. At higher elevations and on north-facing slopes, cold temperatures restricted growth and reproduction of *B. tectorum*. At lower elevations, soil water availability as influenced by precipitation patterns and soil characteristics determined *B. tectorum* establishment. Soil nitrogen and water availability increased following fire especially after removal of perennial herbaceous species. Fire and removal of perennial herbaceous species had only minor effects on emergence and survival of *B. tectorum*. However, biomass and seed production of *B. tectorum* increased 2 to 3 times following removal, 2 to 6 times after fire, and 10 to 30 times following removal and fire. Following disturbance *B. tectorum* can take advantage of increased resource availability to maintain higher growth rates than perennial grasses, and positive feedbacks can facilitate its expansion. However, mature perennial herbaceous species can effectively exclude or limit *B. tectorum* establishment and reproduction and significantly increase resistance to invasion by *B. tectorum*.

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1303 **Chappell, Linda**[*] and Robert Campbell[*]

After the Burn: Twitchell Canyon Wildfire 2011 Post-fire Vegetation Response

Abstract: The Twitchell Canyon wildfire (2010) grew to nearly 45,000 acres on the Fishlake National Forest in south-central Utah. Pre-fire conditions, fire history, current year fire indices, fire progression, and burn severity will be discussed for this fire, which burned for more than 100 days. Extensive Burned Area Emergency Response (BAER) treatments were implemented. The response of fire adapted species will be demonstrated.

[*]USDA Forest Service, Fishlake National Forest, Richfield, UT

903 **Christman, Laine**[*], Mimako "Mimi" Kobayashi[*] and Kimberly Robbins[*]

The Expected Value of Wildfire Potential Information: A Discrete-Space Location-Allocation Problem for Fire Suppression Resources

Abstract: This paper presents a method to calculate daily expected values of using localized, wildfire potential information in the decision making of allocating firefighting suppression resources within a well-defined area of wildland. This well-defined area is referred to as a planning unit under the supervision of a federal agency's fire manager. On any given day during a wildfire season, the fire manager arranges available fire suppression resources in a manner perceived as the most cost effective in fighting potential fires within the planning unit. Suppression resource allocation decisions are based on information regarding the probabilities of a significant wildfire occurring in different areas within the unit. A significant fire is defined as one that cannot be contained by the local resources available for fire suppression within the planning unit. The expected value method identifies allocations of suppression resources that achieve the least expected fire suppression expenditures under various scenarios of wildfire potential predictions using a fire behavior simulation model (BehavePlus). The resulting expenditures are compared with suppression expenditures that would occur when fire potential

predictions were unavailable and the manager had to choose a "default" resource allocation. The default allocation positions the suppression resources at various central locations within the planning unit (i.e. the resource's home station). The difference between the default expenditure and the least-cost expenditure is deemed the expected value of using fire potential information to make resource allocation decisions.

[*]University of Nevada, Reno

606 **Cline, Nathan**[1], Bruce Roundy[1], and Stuart Hardegree

Germination prediction from soil moisture and temperature in the Great Basin

Abstract: Preventing cheatgrass (*Bromus tectorum* L.) dominance associated with frequent wildfires may depend on successful establishment of desirable species sown in rehabilitation and fuel control projects. Ranking potential species success to develop more performance-based species selection for revegetation of rangelands can be done with thermal germination models. Using previously-developed germination models, we compared predicted-thermal progress toward germination (or germination progression) for eight cheatgrass collections, six bunchgrasses, and three forb species using near surface (1-3 cm) soil water potential and temperature at 31 sites in the Great Basin. We also compared the effects of fire, herbicide applications, and mechanical treatments on germination progression. Sites included grasslands (*Elymus spp*. and *Agropyron spp*.) and sagebrush stands (*Artemisia spp.*) either invaded or not invaded by woodland species (*Juniperus spp.* and *Pinus spp.*). Progress toward germination in field seedbeds was summed from field soil temperatures (> 0 ^{0}C) when soil was wet (> −1.5 MPa) as measured by thermocouples and gypsum blocks. Soils were wet and warm enough in spring that germination was predicted for most species. However, some perennial grasses and forbs had limited germination progression and may not be suitable for seeding some locations. In general, predicted germination progression was highest for most cheatgrass collections compared to germination progression of perennial grasses and forbs. Treatments had less effect on surface soil moisture and temperature and germination progression than did site, season, or year.

[1]Brigham Young University, Provo, UT

902 **Collins, Brandon**[1], Richard Everett[2] and Scott Stephens[3]

Impacts of fire exclusion and recent managed fire on forest structure in old growth Sierra Nevada mixed-conifer forests

Abstract: We re-sampled areas included in an unbiased 1911 timber inventory conducted by the U. S. Forest Service over a 4000 ha. study area. Over half of the re-sampled area burned in relatively recent management- and lightning-ignited fires. This allowed for comparisons of both areas that have experienced recent fire and areas with no recent fire, to the same areas historically based on early forest inventories. Our results indicate substantially altered present forest conditions, relative to the 1911 data, and can largely be attributed to the disruption of the key ecosystem process for these forests, fire. For areas that burned recently there was a noticeable difference in forest structure based on fire severity. Current tree density and canopy cover in areas burned recently with moderate severity did not differ from 1911 estimates, while areas that burned recently with low severity or were unburned had higher tree density and canopy cover relative to the 1911 estimates. This emphasizes an important distinction

with regard to using fire to restore forests, resting primarily on whether fires kill trees in the lower and intermediate canopy strata. Our results also demonstrate nearly a doubling of live tree carbon stocks in the present forest compared to the historical forest. The findings presented here can be used by managers and ecologists interested in Sierra Nevada mixed conifer systems.

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904   **Comfort, Emily**[*], Christopher Dunn[*] and John Bailey[*]

Fire Regimes, Forest Change and Restoration of Forested Landscapes in the Middle Applegate Watershed, Oregon

Abstract: Managers are restoring dry-forest landscapes in southwestern Oregon to meet current ecological needs and provide resilience to future climate change and perturbations. More comprehensive knowledge about disturbance histories and developmental pathways is fundamental to this management, so we examined variability in landscape- and stand-scale disturbance and development history within the Middle Applegate Watershed. Cross-sections were removed from conifer and hardwood trees less than 7.62cm DBH in 50m2 circular plots systematically across the watershed; tree cores were removed from all trees 10 – 25cm DBH in 100m2 circular plots, 25 - 60cm DBH in1000m2 plots, and trees greater than 60cm DBH were sampled in 1ha plots. Wedges or cross-sections were removed from available fire scars within and adjacent to plots. All tree ring records and fire scars were cross-dated with master chronologies developed from our tree ring samples. We classified the landscape into archetypal groups using cluster analysis based on species composition, age and size-class distributions, fire history and physiographic position. For the stand-scale analysis, we sub-sampled a portion of our plots within the archetypal groups and stem-mapped the plots to investigate the compositional and spatial characteristics of these groups. Our results suggest multi-scale spatial heterogeneity exists but can be quantified to assist managers in setting restoration targets. Specifically, archetypal groups acknowledge heterogeneity at broad scales that can be combined with stand-level estimates to determine residual variability in composition, density, and spatial-arrangement of stems. Successful restoration practices at such a range of scales can add resilience to landscapes given uncertain future conditions.

[*]Oregon State University, Corvallis

203   **Corrow, Allissa**[1], Rachel A. Loehman[1], Karin L. Riley[2] and Isaac C. Grenfell[1]

Simulating effects of cheatgrass invasion and climate changes on wildfire patterns in an old-growth western Juniper ecosystem: implications for management and restoration

Abstract: The invasive annual cheatgrass (*Bromus tectorum*) has gained notoriety for its dramatic colonization of over 20,000 km^2 of the Great Basin and much of the dry landscapes of the western United States. Many of these areas were previously thought to be 'fire-safe" due to the discontinuous and sparse fuel bed, with fire regimes characterized by infrequent and patchy fires. Cheatgrass invasion has been demonstrated to increase fire frequency, intensity, and extent by providing a continuous and resilient surface fuel, effectively converting many semi-arid woodland ecosystems into self- perpetuating, highly flammable grasslands. The invasion risk by cheatgrass is best predicted by summer, annual and spring precipitation, which have a high degree of uncertainty in climate

projections. Here we employed the wildfire risk simulation system, FSim, to determine burn probabilities under various cheatgrass fuel loads and energy release components (ERCs) for an old- growth western Juniper (*Juniper occidentalis* Hook var. *occidentalis*) woodland in central Oregon. The Horse Ridge Research Natural Area is an ecologically and historically rich area, with very little management and some of the oldest trees in the Intermountain region, many exceeding 1000 yrs. Our results indicate that cheatgrass loading and spatial distribution, as well as climatic variables, affect burn probability and potential for subsequent type conversion and fire regime shifts. These findings may potentially be useful for designing and prioritizing landscape treatments to buffer the potentiating effects of climate changes on weed invasions and fire risk.

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1101   **Cueno, Kate[1]**, Monique Rocca[1] and Cody Wienk[2]

Initial Results Following Thinning and Chipping Ponderosa Pine

Abstract: Chipping or mastication of mechanically thinned fuels is becoming a common fuels reduction technique that aims to both reduce the risk of catastrophic fire and dispose of non-merchantable thinned material. We examined the ecological effects of thinning and chipping in ponderosa pine forests at two National Park Service locations in the Black Hills, South Dakota. By using an unthinned control and a thin-only treatment to compare to thin-chip treatment we were able to separate the effects of thinning from the effects of wood chip application. A greenhouse experiment was used to assess the effects of wood chip depth on seedling emergence and growth of several grass and forb species common to the study sites. Thin-only and thin-chip treatments greatly reduced hazard fuels by lowering pole tree density. Thinning did not elicit much of an understory response in the first year following treatment, while wood chip application caused slight decreases in understory plant richness and cover. There was no difference in non-native species cover or richness, or in overall plant community composition as a result of treatments. Ponderosa pine germinated equally well in wood chips as in other areas. In the greenhouse, increasing wood chip depth created an increasing barrier to seedling emergence and growth. Although wood chip application slightly reduced some measures of understory cover and richness, the results we detected were subtle. Future examination will determine if delayed thinning effects reverse the slightly suppressive effects of wood chip application on understory vegetation.

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204   **Davies, Kirk**[*]

Fire Management for Preventing and Controlling Exotic Annual Grass Invasions

Abstract: Management of fire is critically important in the sagebrush ecosystem where exotic annual grasses are spreading rapidly. Historically, in the sagebrush ecosystem, infrequent fires shifted vegetation dominance from sagebrush to native herbaceous vegetation. Unfortunately, fires in sagebrush communities now often promote exotic annual grass invasion. The risk of exotic annual grass invasion increases substantially when fire-induced mortality of perennial bunchgrasses is high. Annual grass invasion often promotes frequent wildfires creating a grass-fire cycle that facilitates the continued dominance of the community by annual grasses. Thus, it is critical to break the annual grass-fire cycle to prevent the

continued expansion of exotic annual grasses. However, fires can be used to help control exotic annual grasses and establish perennial bunchgrasses. Early summer fires that occur before annual grass seed maturity can decrease exotic annual grasses and increase the success of subsequently seeded perennial bunchgrasses. Prescribed burning can be used to remove litter to improve pre-emergent herbicide control of annual grasses and create a favorable seedbed for perennial bunchgrass establishment. Livestock grazing can decrease the risk and severity of wildfires by reducing fine fuel accumulations and continuity. Fire management that promotes or maintains perennial bunchgrasses is critical to successful invasive annual grass prevention and control. Fire management can have profound influence on exotic annual grass control and invasion; however, proper management may vary by a host of factors.

[*]USDA Agricultural Research Service, Burns, OR

901   **Dean, Alison E.[1]**, Geoff Babb[1], Bryon Scholz[2] and Deb Mafera[3]

Coyote Hills: an adaptive management case study

Abstract: In 2009 Central Oregon Fire Management Service (COFMS) incorporated an adaptive management loop into its burn plan template, with apparent improvement in collaboration, trust, and timeliness in prescribed burn projects. Factors that facilitated a streamlined process will be described in this presentation. Adaptive management describes the iterative process of planning and implementing ideas, monitoring and evaluating results, and using that knowledge to improve the next round of planning. COFMS fire ecologists have emphasized this concept in a series of one-day workshops designed to encourage collaborative planning of prescribed burns. Participants, natural resource specialists and fuels managers at all levels, were assigned to 'interdisciplinary teams' (IDTs) that worked through exercises to identify challenges and solutions at different stages of a burn project. The most commonly suggested solution for a variety of challenges was that agency leadership should encourage IDTs to go together to the field site. In May 2011, an after-action review that included a line officer, fire ecologists, fuels staff, and resource staff was held at a grassland unit that had been burned the previous summer. The discussion of lessons learned at that burn was used to develop goals for the ensuing and adjacent Coyote Hills burn project. A subsequent fieldtrip built consensus in defining implementation objectives, constraints, data needs, and opportunities for monitoring. The team agreed to try a variety of treatments to prevent spread of known infestations of Medusa Head (*Taeniatherum caput-medusae*) in order to learn how better to manage the invasive species in future projects.

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202   **Decker, Cheryl[*]** and Eric Lassance[*]

Fighting Cheatgrass Instead of Fire in Zion National Park—Summary of Treatment Effectiveness and Lessons Learned

Abstract: This presentation will summarize treatment effectiveness and lessons learned from ten years of cheatgrass work at Zion National Park including two landscape scale projects through the National Park Service Burned Area Emergency Response Program. Lessons learned include types of biomass reduction, timing of treatments, herbicide rates and methods, delivery systems,

herbicide combinations, and seeding. We will also illustrate how Zion has synthesized these lessons into creating fuel breaks in Zion's cheatgrass dominated main canyon.

*National Park Service, Zion National Park, Springdale, UT

804   **DeMeo, Thomas E.**[1] and Christopher D. Ringo[2]

Anticipated Effects of Water Balance Deficit on Fire Regime Class at Mid-Century In the Blue Mountains, Oregon

Abstract: Fire Regime Condition Class (FRCC) is an assessment of departure from the range of historical variation. Current seral stage abundance by potential vegetation type (biophysical setting), along with current fire frequency and severity, are compared with modeled estimates of historical (pre-European settlement) values. FRCC is a useful planning tool in developing thinning, prescribed fire, and wildland fire use strategies. Climate change in the Pacific Northwest is expected to result in increasing temperatures and changed precipitation patterns and intensity. One of these anticipated changes is generally increasing water balance deficit (WBD) during the summer growing season. Increasing WBD is expected to affect vegetation through increased moisture stress, decreased growth, and increased susceptibility to disturbance agents of insects, disease, and fire. In order to make an initial assessment of WBD on ecological departure, we overlaid projected WBD at mid-century (approximately 2050) on a current FRCC layer. We used the WBD projection developed by Littell and others at the Climate Impacts Group, University of Washington. Our pilot study area was the Blue Mountains ecoregion of northeast Oregon and southeast Washington. The resulting WBD-FRCC classes suggest ecosystems that are departed now (i.e., less ecologically sustainable and resilient) are likely to become more so. The next step in our investigations will be to see how this relationship varies with biophysical setting.

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806   **Dicus, Chris**[*]

Simulated carbon dynamics in post-fire successional pathways of the Wasatch Mountains, Utah

Abstract: I modeled stand-level wildfire behavior, above- and below-ground carbon storage, and fire-induced carbon emissions in four distinct post-fire successional pathways that were identified in ~100-year old subalpine stands in the Wasatch Mountains of northern Utah. Successional pathways after stand-replacing fires included (1) immediate colonization by climax Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*), (2) colonization by early-seral quaking aspen (*Populus tremuloides*) followed by understory regeneration of spruce/fir, (3) colonization by early-seral lodgepole pine (*Pinus contorta*) followed by spruce/fir, and (4) colonization by lodgepole pine followed by a low-intensity surface fire and then spruce/fir. I used the Fire & Fuels Extension of the Forest Vegetation Simulator to simulate all outputs. Model inputs included field measurements of tree species and size, surface and canopy fuels, tree regeneration, and historical average and extreme fire weather scenarios. In general, the most carbon was stored in the spruce/fir successional pathway followed by the lodgepole pine, lodgepole pine (2 fires), and then quaking aspen pathways. Under both weather scenarios, potential fire behavior (and subsequent

emissions) were also greatest in the spruce/fir pathway due to the amount and continuity of surface and canopy fuels there. Potential emissions were least in the quaking aspen pathway even though advanced regeneration of spruce/fir grew more rapidly there than under lodgepole pine. Thus, fuel treatments should be prioritized in the spruce/fir pathway if positive carbon accounting is a principal management objective.

[*]California Polytechnic State University, San Luis Obispo

1004   **Dillon, Gregory**[1], Zachary Holden[2], Penelope Morgan[3], Michael Crimmons[4], and Emily Heyerdahl[1]

Both topography and climate affected burn severity in forests and woodlands of the western US, 1984 to 2006

Abstract: Severe fires kill and consume large amounts of above- and belowground biomass, with lasting consequences for vegetation structure and composition, soils, aquatic ecosystem productivity and diversity, and many other ecosystem processes and properties. To better understand the factors influencing where, when, and why fires burn severely, we analyzed observations of, and trends in, burn severity in forests and woodlands in six ecoregions in the western United States from 1984 to 2006. Using satellite-derived burn severity data from 1,521 fires from the Pacific Northwest to the desert Southwest, we examined the relative influence of fine-scale topography and coarse-scale weather and climate on burn severity (the degree of change from before the fire to one year after) with the Random Forest machine learning algorithm. Together, topography, climate, and weather explained severe fire occurrence with accuracies ranging from 68 to 84%. Topographic variables were relatively more important predictors of severe fire occurrence than either climate or weather variables. Predictability of severe fire was consistently lower during years with widespread fires, suggesting that local control exerted by topography may be overwhelmed by regional climatic controls when fires burn in dry conditions. Annual area burned and area burned severely were strongly correlated, and both have increased in recent years in all ecoregions. Our results have important implications for fire management, and suggest that predictive mapping of the potential for severe fire is possible and will be improved with higher spatial resolution weather and climate data.

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303   **Donato, Daniel**[*] and Monica Turner[*]

Assessing forest fuels after bark beetle outbreaks and other disturbances: What can fire models tell us?

Abstract: Across the western U.S., there is increasing interest in how disturbances such as bark beetle outbreaks affect fuels and wildfire potential. These events can generate large quantities of dead material in both the canopy and surface layers, generating concern that subsequent fires may burn with greater intensity and severity. Evaluating changes to fuel profiles following such disturbances is an active area of research; however, reported results have varied depending in part on how fire models are applied. We present fuel profile data following various disturbances (e.g., bark beetles, wildfire) in Douglas-fir (*Pseudotsuga menziesii*) forests of the West, assessing how these vary depending on disturbance type and time since the event. We then explore the utility of

various fire models in relating measured fuel profiles to potential fire behavior in these post-disturbance environments. Because many disturbances not only generate dead material but also increase spatial heterogeneity (canopy biomass thinning, intermixing of live and dead foliage, gap creation, and surface fuel patchiness), some limitations of common fire models may become amplified in the post-disturbance setting—particularly those associated with assumptions of a homogeneous fuel bed. Based on empirical data, we highlight which aspects of disturbance-altered fuels are likely to be effectively captured by different types of fire models, and which aspects are likely overlooked even though they may have an important influence on fire potentials. We suggest that, until improved fire models become widely available, detailed fuel profile data provide the most rigorous inference for most studies.

*University of Wisconsin, Madison

807   **Dunn, Christopher*** and John Bailey[*]

Incorporating Snag Dynamics into Estimates of Post-fire Carbon Emissions from Dead Biological Legacies

Abstract: Snags in dry-mixed conifer forests are hypothesized to decay at slower rates than logs, so long-term decay and carbon dynamics are dependent on decay rates of standing and surface coarse woody detritus (CWD) as well as rates of snag deposition. We estimated decay rates of *Pinus ponderosa* and *Abies* sp. snags and *P. ponderosa* logs, as well as estimated snag fall and breakage rates for *P. ponderosa*, *Abies* sp., and *Pinus contorta* snags in three DBH classes (<23 cm, 23-41 cm and >41 cm) across a 24-year chronosequence of high-severity fire sites. *Abies* sp. snags exhibited significant decay (k = 0.0149 yr-1) but *P. ponderosa* snags did not. *P. ponderosa* log sapwood and heartwood did exhibit significant decay (k = 0.0362 yr-1 and k = 0.0164 yr-1), confirming hypothesized differences in decay rates between snags and logs. *Pinus* sp. had estimated half-lives of 7 and 12 years for small and medium snags and 17 years for large *P. ponderosa* snags, and *Abies* sp. snags had estimated half-lives of 8, 14 and 20 years, respectively. Breakage rates were variable across species and size classes. We quantified the effects of snag dynamics on legacy CWD carbon emissions and stores, and found that assuming surface decay rates immediately following fire disturbance overpredict carbon emissions from legacy CWD for 20 years and underpredict thereafter. This results in under-predicting legacy CWD carbon stores by >20% from 14 – 115 years post-fire and suggests legacy CWD carbon stores are conserved on-site in greater amounts than previously thought.

*Oregon State University, Corvallis

709   **Dunn, Christopher J*** and John D. Bailey[*]

Comparison of Forest Structure and Carbon Dynamics between Intensively Managed and Unmanaged Forest Environments Following Fire Disturbance

Abstract: Western hemlock forests of Oregon's Southern Cascades are ecologically and economically important forests experiencing natural and human disturbances dominated by fire and harvest activities. These disturbances exert significant force on the spatial distribution of forest vegetation, stand structure and carbon dynamics. The cumulative effect of these disturbances results in post-fire landscapes developing along multiple pathways dependent on pre-fire conditions and burn severity. Carbon dynamics must account for the effects and interactions of these disturbances. Significant "fire years" occurred within this region at during

1987-1991, 1996, 2002 and 2009. These "fire events" offer multiple fires with pre-fire conditions that allow comparison of intensively managed and natural post-fire environments. Managed stands include previously harvested stands that occurred <5, 5 – 15, 16 – 25, and 26 – 35 years prior to these fire events which have experienced a gradient from unburned to high-severity fire. Natural stands are being sampled across the same burn severity gradient and include any stand > 150 years of age. Salvage logged sites are included to assess the impacts of converting natural stands to intensively managed forest systems following a fire. Pyrogenic emissions, on-site carbon stores and carbon stored in wood products will be considered across this chronosequence and modeled into the future using LANDCARB. By tracking carbon dynamics across time, we can evaluate the long term carbon balance in managed and unmanaged stands. This information will provide us with an understanding of carbon dynamics in post-fire natural and managed stands and which developmental path leads to highest positive carbon balance over time.

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504   **Eitel, Jan U. H.[1],** C Jason Williams[2], Lee A. Vierling[1], Osama Z. Al-Hamdan[1,2], and Frederick B. Pierson[1]

Surface roughness effects on concentrated flow erosion processes in rangelands pre- and post-fire

Abstract: Surface roughness is thought to affect concentrated flow erosion - a major mechanism of soil loss on disturbed rangelands. However, quantifying surface roughness in the field at appropriately fine spatial scales is laborious and the scale at which to conduct meaningful roughness measurements is difficult to discern. Recently, field-portable terrestrial laser scanners (TLS) became available that allow to map surface topography at the sub-cm level. To test the effect of surface roughness on concentrated flow erosion processes in rangelands pre- and post-fire, we used concentrated flow simulation techniques at 8.5 m^2 plots that were randomly placed at rangeland sites in southeastern Oregon and southwestern Idaho, USA. Local surface roughness (locRMSH) was calculated as the standard deviation of TLS mapped surface heights within moving windows varying in size from 30x30 to 90x90 mm. The mean locRMSH of the eroded area and entire plot were negatively correlated (r^2> 0.71, RMSE < 95.97 g min^{-1}, and r^2 > 0.74, RMSE < 90.07 g min^{-1}, respectively) with concentrated flow erosion. The strength of the locRMSH - erosion relationship and regression model parameters were affected by the moving window size, emphasizing the scale dependence of the locRMSH - erosion relationship. Adjusting locRMSH for slope effects decreased the strength of the locRMSH - erosion relationship from r^2 < 0.83 to < 0.26. Further research is needed to evaluate the locRMSH - concentrated flow erosion relationship over a wider range of burn severities, soil properties, surface conditions, and spatial extents.

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502   **Etyemezian, Vic***, David Shafer*, Julianne Miller*, Lynn Fenstermaker*, Karletta Chief*, Ilias Kavouras*, and James King*

Wind erosion measurements up to three years after a fire

The potential for wind erosion is being monitored at the site of a 2008 wildfire near Hiko, Nevada and at the site of a 2009 prescribed fire near Ely, Nevada. Measurements of wind erodibility were conducted at twice or more annually using

a portable wind tunnel-style instrument (PI-SWERL). During each measurement effort, five to ten replicate measurements were completed on native soil that was not within the fire area, burned plant mounds, and vegetation interspaces within the burned area. Dust particles suspended by the PI-SWERL were sampled onto filter media for chemical analyses.

The Hiko site is representative of the transition region between the Mojave and Great Basin Deserts. It is dominated by Blackbrush and Mormon tea. Based on two years of measurements, it appears that this site has started to return to pre-burn levels of wind erodibility. Similarly, the signature of the fire, as parameterized in the elemental carbon to soil ratio started to fade one year after the fire and may be essentially absent two years after the fire. The Ely site is within the Great Basin and is characterized as a sagebrush steppe and pinyon pine and juniper community. Based on one year of measurements, it appears that the potential for windblown dust emissions remains elevated at the plant interspace and plant understory areas of the burned region as compared to the control (unburned) area. Emissions from burned plant understory areas are highest and exceed emissions from control areas by more than a factor of ten.

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503   **Germino, Matthew J.[1]**, Joel Sankey[2], Nancy Glenn[3], Amber Hoover[4] and Natalie Wagenbrenner[5]

Surface conditions affecting post-fire wind erosion in cold desert

Abstract: Wind erosion following rangeland fires is an increasing problem, but its occurrence is highly variable among and within burn sites. The purpose of this presentation is to compare and contrast patterns of post-fire wind erosion for several wildfires that occurred on relatively flat terrain having silty to sandy loam soils, in the northern Great Basin from 2006-2010. First-hand reports and photographs of dust, observations of geomorphic impacts of erosion, or direct measurements of dust production were combined from previously published and unpublished (and therefore preliminary) sources. No evidence for erosion was detected on five wildfires that were smaller than 100 hectares, whereas appreciable sediment transport occurred on burn areas larger than 400 ha, in both published and preliminary observations. On burn sites that exhibited erosion, there was a high temporal variability in erosion rates that were linked to post-fire greenup above threshold levels, and to surface moisture prior to greenup, in both preliminary and published data. High spatial variability in erosion was also evident in preliminary wind-tunnel data, with microsites that had shrubs before fire appearing to have relatively high sediment supply potential compared to other microsite types. Preliminary comparisons of erosion among sites suggest that post-fire erosion rates could be greater from landscapes that had greater shrub abundances before fire. Fire size, vegetation condition before fires, and weather patterns affecting surface moisture are factors that can contribute to post-fire erosion.

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1006   **Gilbertson-Day, Julie[1]**, Alan Agar[2], Nicole Valliant[2], Matthew Thompson[3], and Dave Calkin[3]

Sensitivity of fire behavior metrics to change in fuel data resolution and

implications for landscape wildfire risk analysis

Abstract: The widespread use of fire spread models in federal fire planning applications and decision support tools has been facilitated by LANDFIRE spatial fuels data. Typically, LANDFIRE data are re-sampled from their native 30 m format to larger pixels for more efficient processing of large (e.g. 50,000 – 500,000 ha) landscapes. Despite this common re-sampling of LANDFIRE fuels data, the effect of grid size on fire simulation outputs has not been examined. We hypothesized that different grid sizes could substantially affect wildfire simulation outputs, partly due to the mechanics of fire growth algorithms, and due to spatial grain of surface and canopy fuel. These differences have the potential, therefore, to influence perception and quantification of wildfire risk in areas coincident with mapped human and ecological values. We used a command line version of FlamMap ("Randig") to simulate fires under constant weather at ten different pixel sizes (30 – 300 m) and analyzed changes in (1) burn probability, (2) flame length, and (3) fire size. Minimal increases were generally observed in combination with increasing resolution in all three metrics; however, preliminary ANOVA results suggest differences in output metrics were not significant between all resolutions. Both mean burn probability and flame length at 30 m were significantly different from eight larger output resolutions, while fire sizes tended to increase more substantially with resolutions greater than 150 m. Additional analyses to account for autocorrelation in fire behavior metrics along with stratification of this process across three fire regimes and changing weather scenarios will provide a more robust understanding of the factors contributing to variation fire behavior results and calculations of wildfire risk.

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507   **Glenn, Nancy[1],** Mike Griffel[1], Jeremy Shive[2] and Matthew J Germino

Remote sensing of post-fire conditions in sage-steppe

Abstract: Pre- and post-fire remote sensing techniques can provide synoptic scale measures of soil and vegetation change due to fire. We utilize a combination of high spatial, spectral, and temporal remote sensing imagery to characterize post-fire conditions that may lead to water and/or wind erosion. Our research on the Jefferson Fire, DOE Idaho National Laboratory (INL), focuses on mapping post-fire soil and vegetation conditions that led to high levels of post-fire wind erosion. This work includes mapping burn severity and unburned patches of vegetation at a fine scale (2 m) with high-resolution satellite imagery. Post-fire exposed bare mineral soil and rock are identified with airborne hyperspectral data (400-2500 nm). The bare mineral soil locations are then correlated to the extent of the areas prone to wind erosion. Satellite-based temporal imagery (MODIS, Landsat) are used to identify the area and timing of the wind erosion. Together, these remote sensing data are useful for informing the prioritization and timing of restoration and rehabilitation projects in fire impacted areas.

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803   **Haas, Jessica**[1], Karin Riley[2] and Nicole Valliant[3]

And the flames went higher? Future trends in burn probabilities and flame lengths under changing climates

Abstract: The scientific literature frequently asserts that climate change will cause fires to become larger and more severe, potentially allowing fires to overwhelm the suppression response system. However, little quantitative evidence exists, and complex feedbacks between vegetation dynamics, precipitation patterns, and fire frequency will further complicate ecosystem responses to climate change. In this project, we use fire behavior simulations to isolate changes in annual burn probabilities and fire intensities due to predicted changes in climate. Thirteen downscaled Global Circulation Models (GCMs) provide predictions of daily future temperature, humidity, and precipitation for two time periods (2046-2065 and 2081-2100). We use these weather parameters to derive predicted future trends and variability in the Energy Release Component (ERC), a National Fire Danger Rating System index used as a proxy for the amount of fuel available for consumption. This variability in the future ERC trend drives simulations of fire spread and behavior in the model FSim. Outputs include annual burn probability and conditional flame length probability on a 270-m grid. We test our methodology in Bailey's Northern Rockies ecoregion of Montana. By using 13 different GCM outputs for the each future time period, we will demonstrate the sensitivity of the FSim model to different modeled future weathers. We compare our results to simulations using current weather parameters in order to establish how fire frequency and intensity will change under different future climates. This information can be used by researchers and land managers to perform formal risk assessments to highly valued resources.

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301   **Hicke, Jeffrey A.**[1], Morris C. Johnson[2], Jane L. Hayes[3] and Haiganoush K. Preisler[3]

Effects of Bark Beetle-Caused Tree Mortality on Wildfire

Abstract: Millions of trees killed by bark beetles in western North America have raised concerns about subsequent wildfire, but studies have reported a range of conclusions about effects. We reviewed and synthesized the published literature on modifications to fuel and fire characteristics following beetle-caused tree mortality and developed a conceptual framework describing expected changes. Differences in these responses occur for different characteristics and with time since disturbance. We also quantified the support (agreement of published studies) or lack thereof (disagreement or knowledge gaps) for this framework. Our conceptual framework is supported by the published literature for many conditions, although disagreement exists in several areas. Key disagreement or knowledge gaps occur in early postoutbreak stages and crown fire behavior responses.

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306 **Hoffman, Chad**[1], Ruddy Mell[2], Penny Morgan[3] and Russ Parson[4]

The use of WFDS to quantify crown fire hazard following bark beetle-caused mortality in lodgepole pine forests

Abstract: Understanding how mountain pine beetle (MPB) outbreaks may affect fire behavior is important in order to evaluate potential implications for fire-fighter safety, fuels management, and fire effects. At present, however, the impacts of such infestations on fire behavior are poorly understood. The effects of MPB attacks on fire likely change over time; early in the attack, potential increases in flammability may arise from dead tree crowns, while later in time, canopy fuel continuity may decrease as dead foliage falls to the forest floor. Additional influences include heterogeneity in the antecedent stand structure, the nature of the beetle attack as it unfolds in time and space, and the atmospheric and live and dead vegetation conditions at the time of the fire.

Here, we combine a spatially-explicit model of beetle attack within a stand with a coupled atmosphere/fire behavior model, FIRETEC, to examine the impacts of MPB outbreaks on lodgepole pine forests over time with different ambient wind speeds. Our results indicate that coupled fire/vegetation/atmosphere interactions dictate the nature of the fire behavior and that both local canopy-fuel conditions and stand structure changes must be considered. Stand structural changes modify wind flows as well as turbulent mixing. Depending on the nature of the outbreak, different fire/atmosphere couplings can emerge. Changes in fire behavior also modify the wind fields around the fire, which subsequently feed back on the fire behavior. These results suggest that the impacts of MPB outbreaks may include periods of accelerated/intensified as well as decelerated/ weakened fire behavior.

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906 **Hollingsworth, LaWen**[1], Faith Ann Heinsch[1] and Laurie Kurth[2]

Application and utility of a prototype fire perimeter database for wildfire operations, project planning, and research

Abstract: Localized and landscape-scale fire management are often framed by an understanding of fire potential as defined by weather and climatology in addition to fire growth and fire behavior exhibited by previous wildfires. Fire perimeters, fire behavior, and weather observations are frequently recorded for wildfires, but there are no national data standards nor is there a readily accessible repository for this data. Details of strategic and tactical decisions utilized during wildfires are generally only available within each individual fire's daily incident action plan with little follow-up evaluation of the effect to fire growth. Even with fire progression data available, it is generally unknown whether large fire growth on a particular day is due to natural or manager-ignited fire growth or was moderated by management actions. We have created a prototype geodatabase of fire perimeter data for 58 fires, which has utility for wildfire operations, project planning, and research. Correlating observed fire behavior and fire growth with weather allows trigger points to be established to define weather conditions conducive for large fire growth. Current fire behavior can be compared to post-implementation fire behavior during project planning using a variety of weather scenarios correlated to actual fire behavior which provides a more thorough and relevant method than the common practice of conducting analyses using a chosen percentile weather that is assumed to correlate with specific fire behavior. Furthermore, additional data can

aid current and future research aimed at improved modeling of fire behavior, fire danger, fire effects, and smoke production.

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706 **Hood, Sharon**[*]

How does Fire and Water Stress Affect Tree Resistance to Bark Beetles?

Wildfire and bark beetles are the two largest disturbance agents in western US conifer forests and have interacted for millennia to drive forest composition, structure, and ecological processes. Copious resin flow through resin ducts is the primary mechanism by which trees repel bark beetle attack. Resin production and the formation of resin ducts are under genetic and environmental control. However, the effects of interacting environmental factors on tree defenses are still poorly understood. Fire is known to increase constitutive resin production in many tree species. This suggests that in fire-adapted species, frequent fire may increase tree resistance to bark beetle attack through systemic induced resistance (SIR) via increased resin duct density. There is also evidence that drought stress reduces inducible tree defenses, which can decrease tree resistance to bark beetle attack and increase mortality. However, past research has shown that low-intensity, frequent fire decreases tree water stress by maintaining low overstory density. My project examines the extent to which fire frequency and water stress alone and combined influence defense and tree survival from bark beetle attacks. Preliminary results suggest that mean resin duct density of ponderosa pine is higher in more frequently burned stands compared to less frequently burned stands and that duct density increases after fire. This implies that low-intensity fire can increase individual tree resistance to bark beetle attack by altering tree physiology.

[*]University of Montana, Missoula

1204 **Houtman, Rachel**[*] and Claire Montgomery[*]

Letting Wildfires Burn

Abstract: Under some circumstances, a managed wildfire may generate positive benefits if allowed to burn. These benefits may include wildlife habitat improvements, reduced forest fire fuel loading and, hence, reduced costs and losses from future fires. This paper will present preliminary results of an effort to develop a decision rule that describes when it is likely to be optimal to allow a given wildfire to burn as a function of ignition location and timing, weather conditions, fuel conditions, expected time until the end of the fire season, and an indicator of the spatial configuration of fuel in the vicinity of the ignition. We are developing the decision rule for a study area in the Deschutes National Forest in central Oregon using an optimization procedure known as approximate policy iteration with policy roll-out. Because one of the potential benefits of allowing a current fire to burn is reduced losses in future fires, we estimate expected loss plus cost for a wildfire with and without fire suppression using repeated Monte Carlo simulations of future fire trajectories. Vegetation is updated in each year by using a deterministic state-transition model. Currently, we examine the results of a choice to suppress or let a fire burn in the current time period, while the baseline policy for all future fires is full suppression. The information we gather from the results of this choice will inform the decision rule for future fires using iterative

dichotomous dependent variable regression on the simulation outcomes.

*Oregon State University, Corvallis

403   Hudec, Jessica[1] and David L. Peterson[2]

Fuel variability following wildfire in forests with mixed severity fire regimes, Cascade Range, USA

Abstract: Fire severity influences post-burn structure and composition of a forest and the potential for a future fire to burn through the area. The effects of fire on forests with mixed severity fire regimes are difficult to predict and interpret because the quantity, structure, and composition of forest fuels vary considerably. This study examines the relationship between fire severity and post-burn fuel characteristics in forests with mixed severity fire regimes. We sampled live and dead canopy and surface fuels across four fire severity classes on three wildfires that occurred on the east side of the Cascade Range, USA, in 2007 and 2008. Empirical fuels data and stand structure and composition characteristics were used to calculate potential surface fire behavior for the four fire severity classes. The results indicate that fire severity influences post-burn canopy fuels and potential fire behavior but does not influence dead, down surface fuel loading for the three fires studied. The wide ranges of values for the fuel components analyzed demonstrate the variability that is characteristic of forests with mixed severity fire regimes and emphasize the need to consider the natural heterogeneity of these forests in fire and fuels management. Quantification of post-burn fuel variability is critical in order to better understand the ecological significance of mixed severity fires and develop restoration strategies that emulate characteristics of the historic fire regime.

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605   Hulet, April[1], Bruce Roundy[1], Steve Peterson[1], Steve Bunting[2] and Ryan Jensen

Characterizing Pinyon-Juniper Woodlands Post Fuel-Reduction Treatments Using High-Resolution Imagery

Abstract: Land managers need to be able to rapidly assess and monitor fuel loads and vegetation composition to evaluate and plan fuel control projects on a landscape scale. This research utilizes high-resolution imagery (0.06 m spatial resolution) to assess the relationship between derived remotely sensed-fuel variables and field-based measurements collected as part of the Sagebrush Steppe Treatment Evaluation Project (SageSTEP). Fuel variables were evaluated on untreated pinyon-juniper woodlands and where fuel-reduction treatments (prescribed fire, tree cutting, and shredding of pinyon-juniper trees) had occurred. eCognition Developer 8.64 software was used to investigate hierarchical object-oriented image segmentation and classification. Spectral, spatial, and textural features produced for each object by eCognition were used to determine thresholds to classify six ground cover groups: shadow, trees, shrubs, herbaceous vegetation (including perennial and annual), non-vegetation (litter and down woody debris), and bare ground. Ground-reference biomass estimates were related to remotely-sensed cover estimates using regression equations. For untreated plots where the shadow component was <10% of the total cover, we obtained correlations between remotely-sensed cover and ground-reference cover: live trees r^2 = 0.90; shrubs r^2 = 0.82; herbaceous vegetation r^2 = 0.78; and bare ground r^2= 0.68. Overall classification accuracies were on average 84% with

producer and users accuracies ranging from 77 to 100%. By utilizing remotely-sensed imagery, we are increasing our understanding of the spatial distribution and quantity of fuel loads and community responses to fuel reduction treatments, ultimately supporting management of the sagebrush biome.

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908 **Hummel, Susan**[*]

National fire severity classes related to tree mortality measured two years post-burn

Abstract: This study investigates how national fire severity mapping related to local fire effects in a mixed-severity wildfire. The presentation will focus on fire severity (as classified by using satellite imagery) and tree mortality (as measured on a stratified, randomly sampled grid). The 300m x 300m grid was established one year following the 2008 Cold Springs wildfire in south-central Washington. Each grid point was located within an area of high, moderate, or low fire severity, as classified by the USDA Forest Service Remote Sensing Applications Center. The first year, ten grid point plots in each of the three fire severity classes were sampled. This pre-sample was used to estimate variation in tree mortality by diameter class and to determine the sample size needed to detect a significant difference in percent basal area mortality by fire severity. The pre-sample power analysis resulted in selecting 30 grid point plots at random from each severity class to sample in summer 2010. On each 10m radius plot all trees were measured and tagged. Their status was recorded (live, dead, likely dead before fire) and classifications of crown conditions were made. Tree data were analyzed by using analysis of covariance. Results indicate a significant difference in percent basal area mortality by fire severity class. The significance of the interaction of fire severity and tree diameter class depended upon including or excluding the trees likely dead before the fire.

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902 **Hummel, S.**[1]; K. Vance-Borland[2], K. Burnett[1], P. Fischer[1], J. Creighton[2], and S. Johnson[1]

Science communication networks: the case of fish and fire

Abstract. Social network analysis is a longstanding method for mapping relationships among people; it is used in fields that include corporate management, military intelligence, and public health. Why does network mapping matter? It enables people to see, often for the first time, patterns of relationships among them, reflect on the effectiveness of those patterns, and self-identify actions that support greater individual and group success. Here, we are surveying and diagramming networks of information flow and problem solving among scientists and practitioners working on "fish and fire" issues (fire, fuels treatments, and post-fire restoration related to riparian and aquatic ecosystems).

We invited over 500 federal resource managers, specialists, and scientists (or "actors"), primarily from the USFS, but also from the BLM, NOAA, USGS, and USFWS in Oregon, Washington, and Idaho, to take an online survey with network, demographic, and values questions related to their work on "fish and fire." Network questions requested the names of people with whom the respondent collaborates or communicates on such issues. Over half of those invited responded, identifying 800 other people and 3000 network relationships. In this

presentation, we will discuss our preliminary results within the context of social network analysis and federal resource management. For example, our network diagrams of the preliminary data revealed that actors with higher GS levels tend to be at the core of mapped "fish and fire" networks; actors cluster by geography and agency; and actors who selected the same priority "fish and fire" research need are often not communicating with one another.   Future work will include: analyzing responses to all three types of questions, reporting results to study participants and agency administrators, and identifying and implementing actions to improve communication and collaboration among "fish and fire" workers. We plan a final survey of participants to evaluate the effectiveness of these actions.

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1203   **Ingalsbee, Timothy**[*] and Tom Ribe[*]

Smoke Signals: New Messages and Policies to Nurture Greater Public Tolerance for Forest Fire Smoke

Abstract: Elimination of prehistoric Indian burning, past fire exclusion policies, and ongoing suppression actions have created an enormous "fire deficit" that requires fire reintroduction to restore ecological integrity and biological diversity in fire-adapted ecosystems across the West. Public opinion surveys reveal a growing public acceptance of controlled burning, and new guidance for the federal fire management policy gives managers more discretion to utilize wildfires for ecological restoration. These developments may help efforts to reduce some of the fire deficit, however, public aversion to smoke and increased air regulator scrutiny may constrain increased fire use. Nuisance smoke draws public complaints to land managers and air regulators even when the smoke may not be violating air quality standards, and in heavily populated and industrialized areas like California, forest fire smoke mixed with high levels of urban air pollution can push regional air pollution into legal non compliance. Thus, air regulators and the public they serve are often pushing fire managers to avoid prescribed burning and to aggressively suppress wildfires which undermine efforts needed to reduce the fire deficit. In this presentation, Firefighters United for Safety, Ethics, and Ecology (FUSEE) will report on our efforts to create new messages to nurture both greater public understanding of the ecological necessity of fire, and more tolerance for forest smoke in ways that may help create more options and opportunities for managers to ignite prescribed fires and manage wildfires for multiple objectives. We will also propose possible air quality regulation remedies for fire managers.

[*]Firefighters United for Safety, Ethics, and Ecology (FUSEE), Eugene, OR

1102   Jain, Theresa[1] and Russell Graham[1] - presented by **Michael Battaglia[2]**

Integrated fuel treatments from the site to the landscape: Restoration of northern Rocky Mountain moist forests

Abstract: Restoration and fuel treatments in the moist forests of the northern Rocky Mountains are complex and far different from those applicable to the dry ponderosa pine forests. We are applying and quantifying integrative silvicultural methods and systems that are applicable for regenerating and growing these, and other early seral species, while maintaining forest characteristics that are relevant to many contemporary forest management objectives. The silvicultural options we developed maintain multiple tree densities, a variety of canopy cover, and enhance old-forest attributes and most importantly, the harvesting, mastication, grapple

piling, and prescribed fire treatments we applied will modify both wildfire intensity and burn severity. We found that the heterogeneous forest structures we created, even with small openings (average size 2.6 ha) and the minor proportion of the landscape (3 percent) treated, would alter a wildfire's progression, flame length, and fire type, according to FlamMap and FARSITE wildfire simulations. This analysis showed the placement, juxtaposition, and location of treatments within the landscape would disrupt a hypothetical wildfire's progression under weather conditions that occurred during one of the worst fire seasons (1967) in the northern Rocky Mountains. We found that masticating fuels after harvest in these multi-species and highly variable forest conditions was as cost effective as grapple piling the fuels and offered additional benefits.

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307   **Jenkins, Michael[1]**, Justin Runyan[2], Wesley Page[1] and Chelsea Toone[1]

The Influence of Fuel Moisture and Monoterpenes on the Flammability of Conifer Fuels

To date, the most commonly used operational wildland fire behavior prediction models have been derived from semi-empirical relationships that assume a steady spread rate in homogeneous surface fuels (Mell et al. 2007). Forests, however, are heterogeneous in species composition, structure and physical and chemical condition. This Joint Fire Science Program-funded project explores changes in fuel moisture, monoterpenes and flammability in western conifers resulting from bark beetle infestations in whitebark pine (*Pinus albicaulis* Engelm.), lodgepole pine (*Pinus contorta* Dougl*.* ex Loud), Douglas-fir (*Pseudotsuga menziesii* var*. glauca* (Beissn.) Franco) and Engelmann spruce (*Picea engelmannii* Parry ex Engelm.). In this paper, we present results from studies conducted in whitebark and lodgepole pines. We sampled four whitebark pine and lodgepole pine crown condition classes as described by Jenkins (2011): G = green, healthy and unattacked; GI = green, but currently infested; Y = yellow, previous year's infestation; and R = red, two to four years post-infestation. Whitebark pine red needle litter was also sampled and evaluated. Crown condition classes were tested for foliar moisture and monoterpene levels and compared for significant changes and/or correlations in the two parameters. The effect of altered foliar moisture and monoterpene levels was evaluated in a series of laboratory flammability tests. Results will characterize how changes in foliar moisture content, and the kind, quality and quantity of volatile monoterpenes affect fire spread modeling. This study will provide fundamental information on the wide range of foliar moisture/ monoterpene values of conifer foliage observed in nature. Future work will describe similar relationships in Douglas-fir and Engelmann spruce.

[1]Utah State University, Logan; [2]USDA Forest Service, Rocky Mountain Research Station, Bozeman, MT

404   **Johnson, Katie[1]** and Kristen Waring[2]

A multifaceted analysis of Fire Monitoring Handbook data from Bryce Canyon National Park

Abstract: Since 1990, fire and resource managers at Bryce Canyon National Park have installed Fire Monitoring Handbook-style vegetation and fuels plots to evaluate ecosystem changes in prescribed fire treatment areas over time. Plot data is being analyzed to determine whether pre-determined management

objectives, e.g. increased native grasses, decreased total fuel load, and reduced tree density, are being met. Using time-series analysis, we are quantitatively comparing pre- and post-treatment conditions through time, with an emphasis on native understory, fuels, and tree species. In addition, to simulate the effect of prescribed fire treatments on fire behavior reduction we are using a forest management and fire modeling program to model forest structure, fuels, and fire behavior through time. Results from the time-series analysis and model simulations will be presented, along with how results from this project will be incorporated, through the adaptive management cycle, into an updated Fire Management Plan.

[1]National Park Service, Zion National Park, Springdale, UT; [2]Northern Arizona University, Flagstaff

304 **Johnson, Morris C.[1],** Jessica Halofsky[2], David L. Peterson[1] and John Bergin[3]

Effects of logging on fuels and fire behavior following a windstorm

Abstract: Post-disturbance logging (salvage logging), or the removal of merchantable timber following natural disturbances, is a common management practice performed on federal lands in North America. Despite the frequency of this practice, few studies have quantified the effects following windstorms or blowdown events. Unlike most studies which focus exclusively on the logging effects following wildfires, we used the Fuel Characteristics Classification System and the Forest Vegetation Simulator to quantify the effects of post-disturbance logging and the pile and burn surface fuel treatment on fuelbed characteristics and fire behavior after a windstorm event. We performed a repeated measures analysis of variance (ANOVA) to compare mean levels of fuelbed depth, fuel loading (1-, 10-, 100-, 1000-hr, and larger fuel categories), and simulated fire behavior variables (rate of spread, flame length, reaction intensity, crown fire potential, and available fuel potential) (1) after a windstorm (before post-disturbance logging), (2) after post-disturbance logging (but before pile and burn surface fuel treatment), and (3) after pile and burn surface fuel treatment. Post-disturbance logging, pile and burn surface fuel treatment and the treatment combination (post-disturbance logging plus pile and burn) significantly reduced the major components which control wildfire behavior, including fuelbed depth, 1-, 10-, 100-hr fuel loadings. For an area that experienced a blowdown event, pretreatment surface fuel loading (<7.62 cm) were low. The pile and burn surface fuel treatment and the treatment combination significantly reduced rate of spread. In our study, treatments did not significantly change flame length, reaction intensity, crown fire potential, and available fuel potential. Our results provide forest managers with justification for implementing post-disturbance logging and surface fuel treatment as a viable option to reduce potential fire behavior following windstorm events in managed Douglas-fir dominated stands in southwest Oregon.

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308 **Jolly, W. Matt[1]**, Russell Parsons[1], Ann M. Hadlow[2] and Greg Cohn[1]

Relationship between foliar moisture, leaf chemistry and ignitability of *Pinus contorta* needles during the early stages of Mountain Pine Beetle attack

Abstract: The Mountain Pine Beetle epidemic throughout North America is altering forest structure but its impact on wildfire potential is uncertain. Very little

is known about how foliar moisture content and chemistry change throughout the various stages of insect infestation and even less is known about how these intrinsic foliar characteristics alter the heat required to ignite the foliage. Here we examine these characteristics throughout the season during the early stages of a pathogen outbreak. Trees were identified as healthy, attacked (dying) or red (dead). Foliar samples were taken weekly throughout the growing season from multiple trees in each category and their fuel moisture, foliar chemistry and time to ignition were measured. Foliar moisture contents varied by an order of magnitude between groups and was lowest in red needles (8.1% - 25%), highest in healthy green needles (81% - 120%) and most variable throughout the season in recently attacked trees. The percentage of dry matter composed of fiber carbohydrates such as cellulose, hemi-cellulose and lignin, nearly doubled in attacked needles primarily due to a decrease in non-fiber carbohydrates such as starches and sugars. Time to ignition varied over four-fold from as little as 11 seconds for red needles to almost 42 seconds for healthy green needles and was strongly related to the various stages of attack. A combined model of foliar moisture content, fiber carbohydrates and fats explained 92% of the variation in the foliar time to ignition. These results suggest that there is a higher likelihood of a fire transitioning from the surface into the crowns of beetle killed trees than that of a healthy green trees given the same surface fire intensity and physical crown characteristics.

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1007   **Jolly, W. Matt[1]**, Ann M. Hadlow[2], Sara McAllister[1] and Mark Finney[1]

Apparent changes in conifer foliar moisture are driven by seasonal dry weight allocation

Abstract: Conifer foliar moisture content has long been used as a metric for crown fire potential and seasonal changes in moisture content have been documented for decades. It is generally thought that decreases in the apparent moisture content of live vegetation correspond to increased water deficits but historic attempts to model seasonal changes in live fuel moisture using common drought metrics have been largely unsuccessful. Here we show that changes in common Interior West conifer foliar moisture content are driven by seasonal changes in foliage dry matter allocation. We sample living foliage throughout the season and measure their moisture content on both a relative and dry weight basis and we also determine their proportional allocations of dry matter to carbohydrates, fats, proteins and inorganic compounds. Decreases in moisture content were directly associated with increases in amount of non-structural carbohydrates (NSC) and fats in the foliage. Changes in the proportions of foliar NSC and fats explain 88% of the variation in seasonal changes in live fuel moisture. Comparable trends were not observed in foliar relative water contents. We also present a simple live fuel moisture model that decomposes apparent live fuel moisture into changes in actual water content and dry matter proportion and we suggest that this method may serve as a better foundation for modeling seasonal changes in live fuel moisture. This work demonstrates the need to evaluate seasonal changes in live fuel moisture from a plant physiological perspective by linking fundamental processes such as photosynthesis and transpiration to assess seasonal changes in conifer fire potential.

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Forest Service, Lolo National Forest, Superior, MT

1106 **Keane, Robert**[*]

Describing spatial variability of surface and canopy fuels in the Northern Rocky Mountains, USA

Abstract: Fire behavior models form the foundation of many applications in fire management and planning, but all fire behavior prediction systems are point models that assume homogeneous fuels when applied across space. Current wildland fire research, however, has found that the variability of fuel across space is much more important to fire behavior than average fuel conditions. This presentation describes a study that investigated the spatial distribution of a number of fuel characteristics of northern Rocky Mountain forested stands to describe, model, and map fuels for fire behavior and effects prediction. Four fuel characteristics were measured in this study -- fuel loadings, particle density, bulk density, and size class distribution – for seven surface fuel components (duff and litter, 1, 10, 100, 1000 hr woody, shrub, herb) and three canopy fuel variables (bulk density, cover, load) within nested plots of varying sizes on a large sampling grid; fuel components were measured using a combination of planar intercept, photoload, and direct collection methods at 1, 5, 10, 15, 25, 50, 75, 100, 200, and 1,000 m intervals on a 1 km^2 plot within which there is a base 100 m grid. We implemented this grid on six common northern Rocky Mountain ecosystem types: pinyon-juniper, sagebrush, mixed-conifer, ponderosa pine, western larch, and lodgepole pine. We calculated the variability of these fuel characteristics by fuel component using conventional statistics. We found that all characteristics were highly variable across space and even across a single fuel particle. This high variability can overwhelm conventional fuel sampling designs and result in inaccurate estimates of fuel measurements, especially fuel loading. Results from this study will be used to develop the next generation of fuel models to be used as input to future fire effects and behavior models to more accurately simulate fires across a spatial domain.

[*]USDA Forest Service, Rocky Mountain Research Station, Missoula, MT

1105   **Keane, Robert**[1], Kathy Gray[2] and Valentina Bacciu[3]

Scaling surface and canopy fuels in the Northern Rocky Mountains, USA

Abstract: Surface and canopy fuels information are the foundation of many applications in fire management and planning, but most fire behavior prediction systems use point models that assume homogeneous fuel conditions across space. Current wildland fuel research, however, has found that the variability of fuel across space is more important to fire behavior than average fuel conditions. This presentation describes a study that investigated the spatial distribution of fuel characteristics in northern Rocky Mountain forested stands to model and map fuels for fire behavior and effects prediction. We quantify spatial variation of forest fuels, and then derive scaling factors that would integrate this spatial variability into the mapping process. Fuel loadings (biomass) for ten fuel components were measured within nested plot sizes on a large 1 km^2 sampling grid using a combination of planar intercept, photoload, and direct collection methods at 1, 5, 10, 15, 25, 50, 75, 100, 200, and 1,000 m intervals. We implemented this grid on six common northern Rocky Mountain fuel types- sagebrush, ponderosa pine, Douglas-fir, western larch, pinyon-juniper, and lodgepole pine. We describe the spatial distribution of fuel loading for these components using a number of spatial statistical techniques such as spatial autocorrelation, connectivity, Moran's I, and variograms. Results from this study will be used to develop the next generation of fuel models to be used as input to future fire effects and behavior models to more accurately simulate fires across a spatial domain.

[1]USDA Forest Service, Rocky Mountain Research Station, Missoula, MT; [2]University of California, Chico; [3]University of Sassari, Sassari, Italy

402   **Kemp, Kerry**[1] and Carol Wessman[2]

Multiple disturbance interactions and their effect on understory response after fire in subalpine forests of northern Colorado

Abstract: Natural disturbances play an important role in structuring forest ecosystems by creating heterogeneous mosaics of forest age patches and species composition. Disturbances have been considered especially necessary in driving population dynamics of overstory and understory vegetation in subalpine forests. However, when multiple, discrete disturbances occur over a very short period of time, they may act synergistically and result in a divergence from typical successional processes. From 1997 to 2002, subalpine forests of northwestern Colorado experienced several widespread disturbances, including extensive windthrow (1997), salvage logging (1999-2001), and severe wildfire (2002). This study examines how the combination of these disturbances interacted to structure the post-fire landscape 5 years following the fire. Herbaceous understory species composition and cover were collected in 25 plots in areas of the Routt National Forest of northwestern Colorado with differing disturbance histories. A geographic information system was used to determine fire severity and distance to nearest intact forest for all plots. Results indicated that pre-fire disturbance history significantly decreased post-fire diversity and proportional understory cover. Furthermore, pre-fire disturbance history interacted with both burn severity and time, implying that spatial patterns of disturbances on the landscape are affected by previous disturbances and have lasting temporal effects on understory recovery of a site. Understanding the synergism of multiple disturbances and their effects on the landscape over time will be an important component of effectively managing ecosystems that may be vulnerable to multiple disturbance regimes.

[1]University of Idaho, Moscow; [2]University of Colorado, Boulder

006   **Kitchen, Stan**[*]

Living with Cheatgrass

Abstract: One of the basic attributes of life is the ability to accomplish purposeful movement. Even plants, anchored in place, find ways to travel. Living things have always explored new neighborhoods. For example, most life forms recognizable today as North American 'natives' are, strictly speaking, descendents of post-impact (65 m.y.a.) immigrants. When viewed in geologic time, the ancestors of some, such as the iconic sagebrush of the American West, were relatively recent arrivals. With each wave of immigrants composition and process of North American ecosystems changed irreversibly. The fossil record reveals that deletions, or extinctions, were a predictable byproduct of these changes. Today the rate of plant migration, and consequently the rate of ecological change, is exponentially higher than in the ancient past due to the mobility of the most traveled of all of earth's species, humankind. One of a host of plant species to hitch an anthropogenic ride from Eurasia to North America was cheatgrass. Cheatgrass found an especially inviting home in the semiarid west and continues to makes new inroads across a broad geophysical spectrum, from hot deserts to high mountain forest openings. As with prior introductions, some rules of the game changed as this new player took the field. For example, it is well know that fire regimes in some sagebrush-dominated ecosystems are drastically altered by cheatgrass. Also as before, there is little reason to hope that either the colonization, or the changes it induces, can be reversed. Unfortunately, there will be losers that will be unable to adequately adapt. So what can or should be done about this 'alien' threat? Is it time to acknowledge the permanence of the cheatgrass invasion and to start thinking about a reasonable 'guest worker program'? If so, what would be key elements of such a program? What knowledge do we lack to properly design and manage such a program? Will a single, simple program work everywhere or will a variety of approaches be needed? And how will we know if the program is working, or how to change it if we discover that it is not? I will explore these questions and a few possible answers.

[*]USDA Forest Service, Rocky Mountain Research Station, Provo, UT

609   **Knick, Steven T.**[1], Steven E. Hanser[1] and Matthias Leu[2]

Short-term response by bird communities to pinyon-juniper removal by prescribed fire

Abstract: Management treatments increasingly are focused on recovering native sagebrush steppe by using large-scale prescribed fire to remove pinyon-juniper woodlands. Many of these treatments are conducted to benefit wildlife, such as greater sage-grouse (*Centrocercus urophasianus*), that depend on sagebrush and are declining across much of their range due to habitat loss. We studied the short-term (≤5 years) response by bird communities to prescribed fire in sagebrush steppe/woodland ecotones at 14 sites across Oregon, Idaho, Nevada, and Utah using a treatment and control design. We plotted yearly changes in bird communities as a trajectory in ordination space using canonical correspondence analysis. Our initial results suggest that prescribed fire shifts the bird community towards an organization more characteristic of a sagebrush steppe association. However, the community shift results primarily from declines in woodland or

ecotone species that lose habitat rather than increases in shrubland birds that might benefit from improved habitat. The large variation in response by bird communities in both treatment and control sites also indicates that large-scale regional dynamics have a strong influence and can potentially confound our interpretation of short-term dynamics. Long-term monitoring will be important at these sites to detect true changes in bird communities as a result of prescribed fire.

[1]US Geological Survey, Boise, ID; [2]College of William and Mary, Williamsburg, VA

702   **Krasnow, Kevin[1]**, Ann Halford[2] and Scott Stephens[1]

Wildfire, management, and regeneration of quaking aspen (*Populus tremuloides*) in the Sierra Nevada and Glass Mountains, California, USA

Abstract: Aspen (*Populus tremuloides*) is considered a foundation species and adds significant biological diversity to conifer-dominated western forests. This species has been shown to be particularly sensitive to climate, and is currently a species of concern due to wide-scale, drought-induced mortality in the Intermountain West. Many California land management agencies have identified aspen restoration as a priority and are conducting conifer removal and prescribed fire treatments in an effort to rejuvenate declining aspen populations. This research evaluates the efficacy of these treatments and compares these treatments with recent wildfires. Experimental questions include:

- Resistance Strategies: Are prescribed fire and conifer removal restoration treatments effective in stimulating asexual aspen regeneration? How do these treatments compare to unplanned wildfires?

- Resilience strategies: How do pre-fire stand composition and fire severity impact post-fire aspen regeneration?

- Response strategies: Is it likely that aspen will be able to successfully migrate via sexual reproduction (seeds) in an era of changing climate?

Generalized linear mixed effects models show that both conifer removal and prescribed fire can be effective restoration treatments but that unplanned wildfire produces significantly higher ramet density than either treatment. A significant negative relationship was found between pre-wildfire conifer basal area and post-fire aspen ramet density, indicating that conifer encroachment negatively impacts aspen resilience to fire. Additionally, a significant positive relationship was found between fire severity and post-fire aspen ramet density and growth rates, indicating that increased disturbance severity favors aspen regeneration and persistence. The likelihood of aspen migration via sexual reproduction will also be discussed.

[1]University of California, Berkeley; [2]Bureau of Land Management, Boise District, Boise, ID

1103   **Kreye, Jesse[1]**, Leda Kobziar[1] and Wayne Zipperer[2]

Effects of mastication on fire behavior and fire effects in litter-dominated fuelbeds

Abstract: Mechanical fuels treatments are being used in fire prone ecosystems where fuel loading poses a hazard, yet little research quantifying fire behavior in these treatments currently exists. Mastication is an increasingly used fuels treatment method being widely implemented across the USA and elsewhere. Mastication is a treatment method that converts shrub and small tree understories into compact surface fuelbeds through mechanical shredding. While few experimental studies have been conducted in masticated fuels, they have primarily been composed of fine woody debris. Palmetto/gallberry understories in the pine flatwoods of the southeastern USA result in fuelbeds dominated by foliar litter when masticated and likely result in different burning behavior and effects. In order to quantify fire behavior in these treatments and address potential consequences, we examined the effects of mastication on fire behavior, and subsequent fire effects, from both field and small-scale manipulative experiments in pine flatwoods of northern Florida, USA. We compared fire behavior (flame height and rate of spread), fuel consumption, and fire damage to trees (basal charring, crown scorch, and crown consumption) between treated and untreated experimental field sites in Osceola National Forest. We also quantified the effects of fuel load and fuel moisture content on fire behavior and both above and below-ground heating during small-scale experimental burning in constructed fuelbeds using masticated fuels collected from the field. Our results indicate that while mastication may reduce fire behavior when sites burn, long-duration surface heating may have ecological consequences that deserve further inquiry.

[1]University of Florida, Gainesville; [2]USDA Forest Service, Southern Research Station, Gainesville, FL

1104   **Large, Jonathan**[*]

Ignition Characteristics of Mulched Fuels

Abstract: Mulched or masticated fuel treatments are used by a variety of agencies for debris removal and clean-up, particularly around transmission corridors. They are becoming increasingly common as a fuel reduction treatment in the wildland urban interface, especially in areas sensitive to smoke emissions from pile or broadcast burning. Unlike consumption by fire mulching does not necessarily reduce the overall fuel load, it merely changes the fuel load and subsequent fire behaviour characteristics. Fire behaviour prediction in mulched fuel types has proven difficult due to the large number of unknown variables, and anecdotal evidence has shown a greater potential for fire behaviour than was previously thought. This project focused on characterizing ignition potential in mulched fuel by using two minute match-drop tests to simulate fire brands in mulched fuels under various conditions, including weather conditions and age. Preliminary results show a high probability of ignition on recent mulched fuel under moderate to dry conditions, however this probability appears to decrease with age. Information on fuel moistures has been collected and associated with weather variables and ignition success or failure. These results are part of a larger project investigating fire behaviour in mulched fuels, the focus of which is to allow managers to better understand the capabilities and limitations what is becoming a readily available tool.

[*]FPInnovations, Alberta, Canada

003 **Littell, Jeremy**[*]

Projected changes in climate in the interior west and implications for area burned by fire

Abstract: The expected trajectory of water limited ecosystems, and particularly climate-sensitive ecosystem processes such as fire, depends on future climate. While nearly all plausible future climates suggest at least some warming over most regions of the West by the late 21st century, there is considerably less certainty surrounding future precipitation. In the interior West of the United States, even the sign of changes, much less the magnitude, of some ecological processes is uncertain because of this uncertainty. Using historical and future scenarios of climate and hydrologic change downscaled to ecosections of the Western U.S., I describe statistical climate-fire relationships during the recent modern record and show potential future changes in area burned across different vegetation types of the interior West.

[*]CSES Climate Impacts Group, University of Washington, Seattle

802 **Loehman, Rachel**[1], Jason Clark[2] and Robert Keane[1]

Modeling Effects of Climate Change and Fire Management on Western White Pine (*Pinus monticola*) in the northern Rocky Mountains, USA

Abstract: Mountainous landscapes have been shown to be particularly sensitive to climate changes and are likely to experience significant impacts under predicted future climate regimes. Western white pine (*Pinus monticola*), a five-needle pine species that forms the most diverse of the white pine forest cover types in the western United States, is vulnerable to an interacting suite of threats that includes climate change, fire suppression, white pine blister rust (*Cronartium ribicola*), and mountain pine beetles (*Dendroctonus ponderosae*) that have already caused major changes in species distribution and abundance. We used the mechanistic simulation model FireBGCv2 to simulate effects of climate change and fire management on western white pines in a mountainous watershed in Glacier National Park, Montana, USA. Our results suggest that warming temperatures favor increased abundance of western white pine over existing climax and shade tolerant species in the study area, mainly because warmer conditions potentiated fire dynamics including increased wildfire frequency and extent that facilitate regeneration. Suppression of wildfires reduced area dominated by western white pine, but fire suppression was less effective at limiting burned area extent and fire frequency in a warmer and drier climate. Wildfires created canopy gaps that allowed for western white pine regeneration at a high enough rate to escape local extirpation from white pine blister rust. Western white pine appears to be a resilient species even under fairly extreme warming trajectories and shifting fire regimes, and may provide a hedge against vegetation communities shifts away from forest types and toward grass- and shrublands.

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601 **McIver, James**[*]

SageSTEP Introduction

Abstract: Sagebrush steppe ecosystems in the western U.S. are undergoing rapid change due to a combination of influences including the invasion of non-native plants, the encroachment of pinyon-juniper-dominated woodlands, and

concomitant changes in fire regimes. Accordingly, land management agencies have launched efforts to restore sagebrush-steppe ecosystems and to reduce the extent, frequency, and intensity of wildfires that threaten both native plant and human communities. Yet little is known on how commonly-used fire and fire surrogate treatments may influence whole ecosystems. The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) was initiated in 2005 as a five-year interdisciplinary research project that would: (1) identify conditions that determine the transition between native sagebrush plant communities and alternate states dominated by woodland or exotic annual grasses; (2) evaluate ecological and other effects of alternative land management practices in landscapes threatened by annual grass invasion or woodland encroachment; (3) and facilitate the flow of information gathered to inform effective management of sagebrush communities in human-influenced landscapes of the Great Basin. The research team includes scientists from five universities and four federal government agencies, representing a wide range of scientific disciplines, working collaboratively at experimental sites covering the region from central Washington to southwestern Utah. Members of the SageSTEP research team will present short-term findings, focusing on fire treatments, and how fire surrogate treatments may or may not emulate their effects. Presentations will cover the breadth of research questions and approaches that are being used to gather ecological knowledge relevant to management of the sagebrush steppe for natural objectives, such as restoration, as well as human objectives such as range livestock production. Presentations will focus not only on key biotic and abiotic components of sagebrush-dominated ecosystems, but also on the ways in which ecological knowledge generated through this work can be used and interpreted by land managers as well as the human stakeholders whose concerns must be weighed in ecosystem management.

[*]Eastern Oregon Agricultural Research Center, Oregon State University, Union

610　**McIver, James**[*] and Euell Macke[*]

Butterfly response to sagebrush steppe fire and fire surrogate treatments: unintended consequences?

Abstract: The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) is a multi-site, multi-disciplinary experiment designed to evaluate ecological response to restoration treatments commonly applied in sagebrush steppe lands that have been encroached by woodlands or invaded by cheatgrass. SageSTEP evaluates a wide variety of ecological variables within several ecosystem components, including vegetation, soils, and both vertebrate and invertebrate fauna. This presentation characterizes sagebrush steppe butterfly communities and evaluates their response to restoration treatments at eighteen sagebrush steppe sites across the Great Basin and surrounding areas. Each of the 18 sites has a control plot, as well as plots that have been prescribe-burned, or treated by cutting, mowing, or herbicides. All active treatments are designed to create conditions that favor colonization or growth of native perennial bunchgrasses. Treatments were implemented at all sites between 2006 and 2009. Following treatment, 314 butterfly surveys were conducted each year between May and July within each plot using a line-transect method. A total of 3,898 individual butterflies were observed, comprising 48 species. Woodland plots generally had about 50% greater species richness than sagebrush steppe plots. At most sites, butterfly response to treatment was subtle, with species composition shifting as expected, toward species preferring more open habitat. Not surprisingly, species with larvae that feed on trees declined significantly after tree removal at those sites where

they were common. Additionally, there was a trend toward declining species richness and abundance at some plots treated with tebuthiron, suggesting that some restoration treatments may have unintended consequences. Continued monitoring for at least 10 years after treatment will be necessary to fully evaluate long-term response of butterfly communities to sagebrush steppe restoration treatments.

*Eastern Oregon Agricultural Research Center, Oregon State University, Union

302 **Meigs, Garrett**[1], Robert Kennedy[1] and Helen Maffei[2]

Mapping disturbance effects on forest fuels: Implications for insect-fire interactions

Abstract: Insects and wildfires are important disturbance agents, catalyzing ecosystem change at multiple spatiotemporal scales. This study combines field, aerial survey, and satellite observations to map insect effects on tree mortality and surface fuels. We stratified the Pacific Northwest study region by forest type, time since insect disturbance, and insect agent (bark beetle: mountain pine beetle [*Dendroctonus ponderosae*] vs. defoliator: western spruce budworm [*Choristoneura occidentalis*]). We compared field measurements at federal inventory plots with Landsat TM/ETM+ spectral trajectories since 1985 and with cumulative mortality estimates from forest health aerial detection surveys (ADS) since 1980. At these sample points, many insect disturbances appeared as persistent mortality signals over many years, making it critical that insect mapping methods capture a wide range of potential signals. Overstory tree mortality ranged widely and was generally partial to moderate (well less than 100% tree mortality) at the plot scale. Down coarse woody detritus estimates were more strongly associated with Landsat spectral indices than aerial observations, although fine woody detritus and forest floor depth were not well correlated with either remote sensing dataset. There are several key implications of scaling these plot-scale measurements to seamless landscape maps, which is an objective of continuing research. Given the likely increase of fire and insect activity in the western U.S., the accurate characterization of insect effects on tree mortality, fuel profiles, and fire hazard will become increasingly important.

[1]Oregon State University, Corvallis; [2]USDA Forest Service, Forest Health Protection, Bend, OR

710 **Meigs, Garrett**[*]

Pyrodiversity in Pacific Northwest forests: A photographic journey through space and time

Abstract: Fire is a pervasive force in many forest ecosystems, but the only thing constant about fire is its inherent variability. Many different kinds of fire influence forest structure, function, and diversity, and it is often stated that pyrodiversity begets biodiversity. Drawing on photographs and maps covering a range of fire ecosystems and spatiotemporal scales, this presentation surveys the pyrodiversity of Oregon and Washington forests. From lush old-growth groves to dry juniper woodlands, and all the forests in between, fire has played a profound role over evolutionary and recent times. Fire interacts in complex and surprising ways with changing climate and other disturbances, including insect outbreaks and salvage logging. In the coming decades, these multiple disturbance interactions are likely to present increasingly complex management challenges. But do we know enough about the range and variability of fire causes and effects to anticipate future pyrodiversity? Can we live in a world with more people, more fire, and more

variable fire? Looking across diverse regions like the Pacific Northwest allows us to see the range of possibilities and appreciate how diverse a process fire really is. Because, as with a river, you never step in the same fire twice!

*Oregon State University, Corvallis

509   **Miller, Mark E.[1],** Matthew A. Bowker[2], Richard L. Reynolds[3] and Harland L.Goldstein[3]

Post-fire rehabilitation treatments and wind erosion in low-elevation rangelands – lessons from the Milford Flat Fire

Abstract: Since summer 2008, we have monitored dust emissions at 25 plots located at the northern end of the 2007 Milford Flat Fire (Lake Bonneville Basin, west-central Utah) to examine the effectiveness of post-fire rehabilitation treatments in mitigating risks of wind erosion. Maximum emissions were recorded during Mar-Jul 2009 when horizontal dust fluxes measured with BSNE samplers ranged from 5.5 to 417.0 g m^{-2} d^{-1} in unburned plots (n=8; data represent averages of three sampler heights per plot), 11.7 to 185.1 g m^{-2} d^{-1} in burned plots that were not treated (n=5), and 7.0 to 14,690.2 g m^{-2} d^{-1} in burned plots that received one or more rehabilitation treatments that disturbed the soil surface (n=12). Fluxes during this period exhibited extreme spatial variability and were highly contingent on upwind landscape characteristics and surficial soil properties, with maximum fluxes recorded in settings downwind of treated areas with long treatment length and unstable fine sand. Nonlinear patterns of wind erosion attributable to soil and fetch effects highlight the profound importance of landscape setting and soil properties as spatial factors to be considered in evaluating risks of alternative post-fire rehabilitation strategies. By the Mar-Jul 2010 period, average dust flux declined by 73.4 percent relative to the comparable 2009 period primarily due to the establishment and growth of exotic annual plants rather than seeded perennial plants. Results suggest that treatments in sensitive landscape settings generally exacerbated rather than mitigated wind erosion during the first three years post fire, although long-term effects remain uncertain.

[1]National Park Service, Southeast Utah Group, Moab, UT; [2]US Geological Survey, Flagstaff, AZ; [3]US Geological Survey, Denver, CO

603   **Miller, Richard**[1], Jaime Ratchford[1], Bruce Roundy[2], Robin Tausch[3], April Hulet[2], and Neil Frakes[3]

Short-term vegetation response to piñon and juniper removal in sagebrush-steppe

Abstract: In response to the recent expansion of piñon and juniper woodlands into sagebrush-steppe in the northern Great Basin region, numerous tree removal projects have been implemented across a wide range of environmental conditions to release understory vegetation. Results have been variable ranging from the restoration of native communities to the increase in exotic weedy species, which makes predicting outcomes difficult. To evaluate the general response of understory vegetation to tree canopy removal in wooded shrublands we set up a region-wide study to evaluate changes in understory foliar cover and density. Eleven study located across four states in the Great Basin region were set up as statistical blocks, each containing a fire, mechanical, and control treatment. Different vegetation and ground functional groups were measured prior to and during the first three years following treatment. There was an immediate increase in bare ground and decrease in tall perennial grasses following the burn but both recovered by the second growing season to preburn and control levels. Tall

perennial grasses increased in the mechanical treatment in the second and third year following treatment. Exotic grasses and forbs did not increase in the burn and mechanical treatment in the first year but increased in the second and third year following treatment. Perennial forbs did not differ across treatments but annual forbs significantly increased in the burn treatment in post-treatment years two and three. Both the recovery and increase in perennial tall grasses did not result from increased seedling establishment following treatment but an increase in size of pre-existing plants. Increase in shrub densities indicate both recovery and increase in the burn and mechanical treatment, respectively. This study supports the hypothesis that plant composition prior to treatment is an important driver in determining early succession following tree canopy reduction.

[1]Eastern Oregon Agricultural Research Center, Oregon State University, Corvallis; [2]Brigham Young University, Provo, UT; [3]USDA Forest Service, Rocky Mountain Research Station, Reno, NV

005   **Morgan, Penny**[*]

Preparing Wildland Fire Professionals for a Changing Future

Abstract: Current and future fire professionals face altered fuels, an expanding wildland-urban-interface, invasive species, more frequent extreme climatic conditions, rapidly advancing technology and fire science, increased cost constraints, and a rapidly changing work force. Preparing fire professionals to tackle this complexity is challenging. Our system for providing education, training, and experience, the three legs of the "professional fire development triangle", to the future wildland fire professionals must be innovative and effective. The Education Committee of the Association for Fire Ecology has suggested that we 1) coordinate course content between universities and the NWCG, as appropriate, to reduce redundancy and promote effective and efficient learning; 2) facilitate experience for university students to provide employers with capable fire professionals; 3) develop avenues to facilitate university education for experienced fire professionals to further improve the adaptability of the current workforce, 4) facilitate efficient transition of new fire professionals into the workforce, and 5) set high, unambiguous standards for the wildland fire workforce to meet future challenges. I will share examples of many innovative, effective efforts addressing these issues. Unfortunately, most are local. We now need similar concerted efforts at regional and national levels that are informed by and expand upon proven local successes. We need to expand our efforts now! Preparing wildland fire professionals more effectively for the future depends on an open dialogue between the agencies that employ fire professionals, the developers and instructors of NWCG training programs, and the higher education providers of degree programs.

[*]Wildland Fire Program, University of Idaho, Moscow

707   **Morgante, Anna**[*]

Incorporating Spotting into a Simple Fire Perimeter Model

Predicting the behavior of a fire which begins to spot can be very difficult for managers. A simple, deterministic, mechanistic model for predicting the perimeter of a fire with active spotting will be an efficient and valuable field tool for managers. This model builds upon established biological invasion theory known as the coalescing colony model. The model will incorporate other established, mechanistic, fire behavior models to predict the perimeter of a fire as it grows by

diffusion and coalescence with spot fires ahead of the front. Elliptical growth models the overall spread of the perimeter of both the main fire and the spot fires. This quantitative, predictive field tool may also be used to determine conditions for which spotting significantly affects the overall spreading behavior of a fire. As a simple model, inclusion into existing simulation and model packages will be simple.

*Humboldt State University, Arcata, CA

508   **Newingham, Beth A.**[1] and A.C. Ganguli[2]

Comparing the effects of post-fire seeding techniques on soil erosion in a dryland ecosystem.

Abstract: Post-fire rehabilitation focuses on stabilizing and rehabilitating ecosystems after fire. In the Great Basin, seed drills are used to stabilize soil and re-establish perennial vegetation in these desert ecosystems. While seed drilling is intended to stabilize soils via vegetation recovery, it is possible tilling directly destabilizes soil and creates erosion problems. We examined the effects of two different seed drills (rangeland and minimum-till drill) on soil erosion. We measured soil microtopography, stability, and dust flux in unburned and burned plus treated plots. Treatments included the two seed drills and different seeding rates. Microtopography was significantly higher in the rangeland plots compared to unburned and burned + minimum-tilled plots. This variation in surface relief decreased over time but spiked again indicating soil movement throughout the year and a half post-fire. Soil stability was significantly lower in burned areas but was not affected by different seed drills or seeding rates. Dust flux rates were 10-40 times higher in burned plots but were not significantly different among seed drills or seeding rates. Dust flux substantially decreased one year after fire with peak dust flux rates approximately 400-700 g/m2/day. Our results indicate that fire dramatically increases wind erosion in these dryland ecosystems during the first year post-fire. While seed drills differentially affected microtopography, there was no detectable effect on soil stability or dust flux. Further studies are needed to tease out effects of seed drills on wind erosion on different soil types.

[1]University of Idaho, Moscow; [2]North Dakota State University, Fargo

808   **Osborne, Kevin**[1], Chris Dicus[1] and Alan Agar[2]

Impacts of alternative landscape-level fuel management strategies on short-term carbon emissions and long-term carbon storage

Abstract: Implementing landscape-level fuel management projects besets land managers with the paradox that fuel management strategies designed to protect valuable resources and property from wildfire also alter the desirable ability of forests to store and sequester carbon. Our research seeks to reconcile this management quandary through quantifiable means in order to advance scientifically-sound, sustainable forest management. We demonstrate how alternative landscape-level fuel management strategies can simultaneously impact (a) short-term carbon emissions and (b) a forest's capacity to store carbon over a long-term cycle. The overriding purpose of the this research is to determine how multiple fuel treatment types, organized in varying spatial arrangements, and at increasing proportions of a mixed-conifer forest in the Klamath Mountains of northern California (~42,000 ha) variably affect short-term carbon emissions and long-term carbon storage. The research presented here compliments and greatly expands ongoing research efforts that explores stand-level (<10 ha) changes to

fire behavior and ecosystem services following diverse fuel treatments in the Klamath Mountains of California.

[1]California Polytechnical Institute, San Luis Obispo; [2]USDA Forest Service, Western Wildlands Environmental Threat Assessment Center, Prineville, OR

1306 **Oswald, Brian P.[1]** and Alette Getz-Smeenk[2]

Addressing Highly underestimated risks of wildland fire in rural–urban interface areas in The Netherlands: a collaborative effort between the Dutch government and Stephen F. Austin State University

Abstract: In the Netherlands the risks of wildland fires are underestimated by the general public, researchers, policy and decision makers of public and private organizations. Research has shown that it is quite probable that uncontrollable wildland fires occur in the country's largest forest and nature area, the Veluwe area: 4 % a year on average, and up to 50 % in years with drought. Additionally, the latest National Risk Assesment shows that rapidly expanding wildland fire incidents transcends the regional capacity of disaster management in various ways. Recently an initiative was launched to start a national program of intergovernmental cooperation in wildland fire risk management. The aim is to develop a strategy of public-private cooperation that leads to the prevention of wildland fire risks as well as the improved performance of the multidisciplinary crisis organization for large wildland fires. There is an urgent need to learn from experiences and research abroad in order to the develop of effective evacuation strategies of green areas in a densely populated country, or any other alternative. The lack of Dutch expertise in wildland fire ecology and fire behavior is addressed by the Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University (SFASU). In the last 18 months, a research and educational relationship has been forged between SFASU, VNOG and various academic institutions in The Netherlands. A visit to The Netherlands has been followed by the submission of research grant proposals, the initiation of student and faculty exchange programs between universities, and internship opportunities for students in both counties. It is anticipated that this new collaborative effort with provide global solutions to this growing problem in The Netherlands.

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1307 Pase, H.A. Joe, III[1] and **Brian P. Oswald[2]**

Drought and Fire in Texas 2011

Abstract. The historic drought of 2011 in Texas has had serious impacts on the 2011 fire season. This presentation provides an overview of the drought and its impact on the fire season, centering on the Bastrop Fire.

[1]Texas Forest Service, [2]Stephen F. Austin University, Nacogdoches, TX

305 **Parsons, Russell[1]**, Chad Hoffman[2], Rodman Linn[3], Carolyn Sieg[4] and Judith Winterkamp[3]

Impacts of mountain pine beetle outbreaks on coupled fire/vegetation/atmosphere interactions in lodgepole pine stands using FIRETEC

Abstract: Understanding how mountain pine beetle (MPB) outbreaks may affect fire behavior is important in order to evaluate potential implications for fire-fighter

safety, fuels management, and fire effects. At present, however, the impacts of such infestations on fire behavior are poorly understood. The effects of MPB attacks on fire likely change over time; early in the attack, potential increases in flammability may arise from dead tree crowns, while later in time, canopy fuel continuity may decrease as dead foliage falls to the forest floor. Additional influences include heterogeneity in the antecedent stand structure, the nature of the beetle attack as it unfolds in time in space, and the atmospheric and live and dead vegetation conditions at the time of the fire. Here, we combine a spatially-explicit model of beetle attack within a stand with a coupled atmosphere/ fire behavior model, FIRETEC, to examine the impacts of a MPB outbreaks on lodgepole pine forests over time with different ambient wind speeds. Our results indicate that coupled fire/vegetation/atmosphere interactions dictate the nature of the fire behavior and that both local canopy-fuel conditions and stand structure changes must be considered. Stand structural changes modify wind flows as well as turbulent mixing. Depending on the nature of the outbreak, different fire/atmosphere couplings can emerge. Changes in fire behavior also modify the wind fields around the fire, which subsequently feedback on the fire behavior. These results suggest that the impacts of MPB outbreaks may include periods of accelerated/intensified as well as decelerated/ weakened fire behavior.

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907   **Pence, Morgan**[*], Tami Parkinson[*] and Kim Ernstrom[*]

Spatial Fire Management Planning within WFDSS

Abstract: Throughout the summer of 2011, the Wildland Fire Management Research, Development and Application (WFM-RDA) group in coordination with the National Wildfire Coordinating Group (NWCG) – Interagency Fire Planning Committee, worked with local units to determine the feasibility and applicability of using the Wildland Fire Decision Support System (WFDSS) to spatially represent guidance/direction from their respective Fire Management Plans. Select units tested alternatives within WFDSS 3.14 to determine if the spatial concept of Fire Management Planning was even practical. This allowed units to test the current capabilities of the WFDSS system, provide feedback as to what worked, and offer potential improvements to the program to better represent the spatial Fire Management Plan concept. In addition, this testing allowed users to experiment with WFDSS and their Fire Management Plans, providing opportunities to re-evaluate their Fire Management Units (FMU), and guidance relevant to each FMU. Lessons learned throughout this testing may be used for future development or restructuring of current Fire Management Planning efforts.

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607   Pierson, Fred B.[1], **C.Jason Williams[1, 2],** Patrick R. Kormos[1, 3] and Osama Z. Al-Hamdan[1, 2]

Runoff and erosion responses on burned and unburned sagebrush steppe and wooded shrublands in the Great Basin, USA

Abstract: Cheatgrass and tree invasions of sagebrush steppe rangelands in the Great Basin have increased the risk of occurrence of large, high severity fires. Fire and woodland encroachment have been linked to amplified runoff and erosion. Runoff and erosion can increase by factors of 2 to more than 100 immediately

following burning of sagebrush steppe. Amplified runoff and erosion from sagebrush steppe following woodland encroachment occurs where shrub and herbaceous species decline and rock cover and bare soil area increase and become more interconnected. Runoff and erosion generally increase exponentially on wooded shrublands where bare soil and rock cover exceeded 50%. Fire removal of the limited cover potentially exacerbates already high runoff and erosion rates from these ecosystems. However, fire removal of tree cover may promote understory development, thereby restoring shrub steppe structure and ecological function and reducing long-term runoff and erosion. This study investigates short-term hydrologic response to burning of historical sagebrush steppe in the Great Basin. Rainfall simulation and concentrated flow experiments were conducted pre- and one and two years post-fire to evaluate the effects of burning on runoff and erosion. We present results in context of the effects of wildland fire and the use of prescribed fire as a tool to manage woodland encroachment in the Great Basin.

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1302 **Pilliod, David**[*] and Robert Arkle[*]

Spring-ignited Prescribed Fires Reduce the Severity of Subsequent Wildfire in Central Idaho

Abstract: Prescribed fires are often implemented to reduce future wildfire severity, but surprisingly few empirical data support this management objective. We examined the effects of three spring-ignited prescribed fires on burn severity patterns of a summer wildfire that occurred 1-3 years post-treatment in a mixed pine-fir forest in central Idaho. Burn severity was estimated as differences in the normalized burn ratio (dNBR) from pre- to post-fire using Landsat imagery. We generated models to predict the wildfire severity of each 30 m pixel that was treated by prescribed fire and compared those results to wildfire burn severity outside the prescribed fire perimeter. We found that an interaction between prescribed fire severity, topographic relative moisture index, heat load index, vegetation type, and vegetation volume best predicted wildfire severity, with prescribed fire severity and topographic relative moisture index being the most influential predictors. Prescribed fire severity was highest in relatively dry locations, such as patches of shrubs and grasses, which were dry enough to burn under spring conditions. Wildfire severity peaked in more mesic locations that supported Douglas fir stands. Thus, although prescribed fire effectively reduced wildfire severity in this study area, moist conditions of mesic forests may limit the effectiveness of spring-ignited prescribed fires at meeting all management objectives.

[*]US Geological Survey, Boise, ID

703 **Poulos, Lauren**[*], Bitty A. Roy[*] and B. Thomas[*]

Prescribed Fire and Its Interactions with the Invasive Bunchgrass, *Brachypodium sylvaticum*

Brachypodium sylvaticum, a shade-tolerant, aggressive invasive native to temperate Eurasia, is classified as a noxious weed in CA, OR and WA, and could possibly cause ecosystem collapse by altering fire regimes. We have divided two sites in the Willamette National Forest into eight units, and randomly selected half for treatment with prescribed fire. Each site has 16 plots with *B. sylvaticum* (8 burned, 8 unburned) and 32 dispersal plots without *B. sylvaticum* (16 burned, 16

unburned). There are four possible outcomes: (1) Fire severity and intensity may increase in well-established areas with the accumulation of finer fuels from *B. sylvaticum*. (2) Conversely, because *B. sylvaticum* stays green late into the fire season, it could have a dampening effect and decrease fire severity and intensity. (3) Fire may facilitate the spread of *B. sylvaticum* by exposing the soil, increasing light levels due to a reduction in canopy and by increasing seed dispersal on crews and equipment. (4) Fire may control the invasive by killing established plants and seeds. Results/Conclusions - The fires were set in the spring of 2011. Pre-burn, site 2 had higher density of *B. sylvaticum* (33 ± 10 vs. 1 ± 0.61/linear m, $P<0.0001$), more canopy cover ($28\pm0.8\%$ vs. $22\pm1.4\%$, $P=0.0003$), and more cover by other plants ($43\%\pm 4.41$ vs. $27.89\%\pm2.46$, $P=0.0007$). We found that with a spring burn *B. sylvaticum* density decreases fire severity, $\chi2 = 11.923,63$ and $P = 0.0077$, with differences between the sites. Future analyses: Does fire influence the abundance and dispersal of *B. sylvaticum*?

*University of Oregon, Eugene

1304　**Prichard, Susan**[1], David Peterson[2] and Travis Freed[1]

Landscape analysis of fuel treatments and wildfire severity in north-central Washington State

Abstract: Under a warming climate and increased fire hazard, managers of dry forests face numerous challenges in reducing wildland fuels to mitigate future wildfire severity. In this study, we evaluated relationships between fire severity and over 300 fuel treatment units burned in the 2006 Tripod Complex fires. Although the main objective of this study was to determine the effect of fuel treatments, a number of other factors likely influenced the extent and severity of the wildfires, including fire weather, vegetation type and structure, landform, and past disturbances. We considered these other factors as potential covariates and were particularly interested in evaluating whether recent mortality from a mountain pine beetle outbreak influenced fire severity. Predictive models of differenced Normalized Burn Ratio (dNBR and RdNBR) were constructed using a combination of regression tree analysis, ordinary least squares (OLS) regression and spatial autoregression modeling (SAR). Across modeling approaches, significant predictor variables of dNBR include fire weather (minimum relative humidity, maximum temperature and average wind for each burn progression interval), landform (elevation and slope), vegetation (canopy closure), and fuel treatments (treatment type and time since treatment). Recent mortality from mountain pine beetle was not a significant predictor of fire severity. Spatial autoregression models have greater predictive ability than OLS models with lower AIC values and much higher R^2 values (0.78 versus 0.42). The spatial autoregressive term of the SAR models shows strong correspondence to areas of high severity, suggesting the importance of missing variables such as local fire behavior and weather in our predictive model.

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602　**Pyke, David A.** [1], Michael D. Reisner[2], Paul S. Doescher[2], Eugene W. Schupp[3], Jeanne Chambers[4], James Grace[5], Scott Shaff[1], Jeff Burnham[3], and Andrew Lindgren[1]

Stress in fire-prone sagebrush steppe and resistance to cheatgrass invasion

Abstract: Fire is a natural driver of succession within sagebrush steppe

ecosystems pushing mixed shrub and grass communities to grass-dominated ecosystems with spatially separated bunchgrasses. Over time, sagebrush reestablishes and becomes prominent again until the next fire. Invasion of cheatgrass into these ecosystems has led to a loss of resilience with succession becoming disrupted and cheatgrass dominating thus forming an alternative stable succession that revolves around frequent fires and continuous fuel. In SageSTEP, we are attempting to understand the resilience of sagebrush steppe ecosystems in light of the invasion and presence of cheatgrass. We have preliminary evidence that as heat stress, water stress and livestock grazing increase, perennial grasses may shift from being spatially separated from shrubs (competitive relationship) to becoming more associated with shrubs (facilitative relationship) and may create larger gaps among perennial plants. These gaps create invasion sites and sites of cheatgrass dominance. Fires lead to some mortality of perennial grasses. This mortality would likely be greater for grasses located near or under shrubs than for those located away from shrubs. Since sagebrush is killed by fire and some perennial grasses will likely die as well, gaps among remaining perennial plants increase and lead to the potential for cheatgrass to become more prominent. Our initial results indicate that simple measures of gap distance among perennial plants may provide an excellent early warning tool for loss of ecosystem resilience in sagebrush grass communities and may aid in understanding those locations where cheatgrass might be expected to increase after fires.

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1005   **Qi, Yi**[*], Phillip E. Dennison[*] and Jessica Spencer[*]

Remote Monitoring of Sagebrush and Gambel Oak Live Fuel Moisture using Soil Moisture and Remote Sensing Proxies

Abstract: Live fuel moisture (LFM) is the water content of live fuels, measured as a percent of the dry fuel mass. This moisture must be driven off before live fuels can combust, making LFM an important indicator of fire danger. To monitor fire danger in a variety of shrubland and forest fuels, BLM and the Forest Service manually sample LFM at dozens of sites within the Interior West. Data provided by remote sensing vegetation indices and soil moisture sensors may provide alternative means for monitoring LFM. Vegetation indices respond to changes in vegetation cover, chlorophyll absorption, and water absorption that are correlated with changes in LFM. Since living plants draw on soil moisture to sustain transpiration, we also hypothesized that soil moisture may also be correlated with LFM. Soil moisture stations were installed at 5 sagebrush LFM sampling sites and 5 Gambel oak LFM sampling sites in 2009 and 2010. Moderate Resolution Imaging Spectroradiometer (MODIS) data were used to produce greenness and moisture indices. Regression was used to compare LFM to soil moisture and MODIS vegetation indices. Relationships were found to be site-dependent, likely due to differences in vegetation cover, vegetation composition, and soil properties at each site. Soil moisture monitoring had better temporal resolution, while MODIS data provided superior spatial coverage. Both monitoring technologies may be valuable for estimating LFM within sagebrush and Gambel oak.

[*]University of Utah, Salt Lake City

001   **Quigley, Thomas M.**[*]

Cohesive Strategy: Potential Changes in Fire Management Direction

Abstract: Driven by Congressional mandate and a recognized need for a national strategy to address wildland fire risk on all lands, the Wildland Fire Leadership Council has initiated the development of a National Cohesive Wildland Fire Management Strategy. The first phase of the process, completed in 2010, resulted in two reports – one that describes the primary objectives of the Cohesive Strategy and the process for its completion and the second responds directly to questions Congress asked about wildland fire and fuels management in the FLAME Act. The second phase is scheduled to be completed in October 2011 as the third phase begins. There are three broad national goals that underpin the Cohesive Strategy: 1) restoring and maintaining resilient landscapes, 2) creating fire-adapted communities, and 3) responding to wildfires. The intent is to have a functioning wildland fire management strategy that reduces and manages wildland fire risk on all lands – meeting the needs of all jurisdictions and landowners. The nation has been divided into three broad regions with committees and working groups organized to develop regional goals, objectives, actions, and activities designed to achieve the national goals from a regional perspective. Concurrent with the regional work is a National Science and Analytical Team developing conceptual models that describe the relationships among factors that influence wildland fire risk to important values and resources. The third phase promises to be an interesting exercise when the regional goals, objectives, actions, and activities are analyzed in a tradeoff analysis using analytical models derived from the available data and conceptual models of the second phase. An iterative process that reveals potential outcomes in wildland fire risk to the regional and national committees and working groups then validates/revises the models and actions/activities and re-runs the analytical models will be the first real attempt at a national approach of this type. There are many individuals and groups involved in the process – each with their own expectations regarding what success will look like. Just how close the resulting strategy comes to achieving a cohesive and effective approach at managing the nation's wildland fire risk remains to be seen.

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1207   **Rau, Amanda**[*]

Anthropogenic Fire in Designated Wilderness on the Deschutes National Forest

Abstract: The history of American forestry and the public lands system is abound with detailed narratives of central figures in decision-making such as Gifford Pinchot, John Muir, and Aldo Leopold, whose promotions of public land stewardship are exceptional and worth studying. American Indian land stewards appear, by comparison, vague, not well understood, largely regarded in federal land management as a part of decision-making as mandated by policy and law, rather than considered essential to a sense of inheritance about how to manage public lands. This project explores the legacy of indigenous land stewardship in Central Oregon, primarily achieved through use of fire as a vegetation management tool, how it appears to have been historically displaced, and how historic native burning practices can be reintegrated into the present fabric of considerations in land management decision-making. Geographically referencing Designated Wilderness Areas on the Deschutes National Forest, where the inherent conflict between the Wilderness Act of 1964 and the historical presence of humans within the philosophically diametric domain wherein "man himself is a visitor," and not a player in the evolution of the landscape, provides a unique opportunity to explore the philosophical foundations of wilderness management, and the natural history

of human ignitions.

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809 **Riley, Karin[1]**, Alan Agar[2], Mark Finney[3] and Andrew McMahan[4]

Risk-based estimates of terrestrial carbon storage and wildfire emissions for the conterminous US

Abstract: As atmospheric carbon dioxide levels continue to rise, terrestrial storage in live and dead vegetation has become an important option for sequestering carbon. However, recent carbon storage estimates for US forests do not account for future potential losses from wildfire. To address this shortcoming, we employed wildfire simulation modeling and a risk analysis framework to estimate expected wildfire emissions and associated losses to carbon stocks. The simulations generated burn probability and intensity estimates for the conterminous United States on a 270-m grid. We obtained figures for standing carbon stocks and emissions under a range of fire intensities by processing a national grid of imputed forest inventory data with the Forest Vegetation Simulator's Fire and Fuels Extension (FVS-FFE). We then calculated expected carbon stocks as the product of the probability of fire of a given intensity and the amount of carbon remaining following a fire of that intensity, summed over all intensity categories. Expected emissions were calculated in a similar fashion. Results suggest that expected carbon storage given fire risk is only about 0.01% lower than current carbon storage, due to two factors: 1) annual probability of burning is low, and 2) most carbon remains onsite immediately post-fire, due to storage in tree boles. However, expected emissions are a significant source of carbon, and analysis of carbon stocks after decay of post-fire mortality would substantially increase expected carbon emissions. Our probabilistic framework offers a robust approach to examine carbon impacts from fuel management activities and linked disturbances such as bark beetles.

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708 **Riley, Karin[1]**, John Abatzoglou[2] and Isaac Grenfell[3]

The Relationship of Large Fire Occurrence to Drought and Fire Danger Indices in the US West, using Downscaled Weather Data

Abstract: The relationship between large fire occurrence and drought has important implications for fire hazard prediction. Previous work, however, has not shown strong relationships between drought and area burned. High spatial resolution climate and meteorological data were used to derive a variety of drought and fire danger proxies including monthly precipitation (PPT), Palmer Drought Severity Index (PDSI), Standardized Precipitation Index (SPI), and daily Energy Release Component (ERC). We identified fire location, date, area burned, and severity using Landsat-derived Differenced Normalized Burn Ratio (dNBR) imagery from Monitoring Trends in Burn Severity. Combining these two datasets allowed us to relate fire and weather variables at a fine temporal and spatial scale. When indices are normalized to percentile, correlations between fire occurrence and short-term indices ERC, PPT, and SPI3 are strong. Short-term indices also demonstrate moderate correlations with fire severity. However, PDSI, SPI12, and

SPI24 appeared to be uncorrelated with fire occurrence at the level of the US West, implying that longer-term drought indices are not correlated with dead fuel moistures, which are determined by weather in the previous 40 days.

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611   **Rollins, Kimberly**[*], Mimako Kobayashi[*] and Michael Taylor[*]

Measuring the Economic Value of Fuel Treatments on Great Basin Rangelands

Abstract: This paper summarizes results from an economic research program that measures economic benefits of fuel treatments on Sagebrush steppe rangelands. Using an approach that combines ecological state–and-transition modeling (STM) with bioeconomic modeling, we estimate economic values that flow from: wildfire suppression costs averted, ranch-level benefits, and non-ranch benefits to other members of society from ecological goods and services losses averted. The magnitudes of costs and benefits depend on parameters that account for fuel types and economic and ecological characteristics. We find that the value of fuel treatment considerably outweigh the costs over a variety of starting fuel type and loadings, and conclude that greater investment in pre-fire treatment would result in overall lower wildfire costs to society. We estimated the value to the public of preserving ecosystem function to be $38 to $52 per household per year, where preventing loss is more highly valued than restoration. The value is less for those self-identifying as being employed in agriculture, but is higher for those who agree that grazing is a priority. For a rancher unaware of the effects of ecological thresholds, treatment is not optimal at $35/acre. However, if threshold effects are taken into account, it is optimal to invest in fuel/vegetation treatment to maintain healthy rangeland states. Incentives for treatment are weaker for large ranches because they have 'buffering capacity' to deal with wildfire costs. Finally, the paper turns to the problem of policy design to align incentives among diverse societal interests for cost effective ecosystem and fuels management.

[*]University of Nevada, Reno

1201   **Rollins, Kimberly**[*], Michael Taylor[*] and Mimako Kobayashi[*]

Ecology and Economics of Fire: Integrated Models

Abstract: The task of estimating the costs of wildfire on Great Basin rangelands, the benefits of landscape level treatments, and the relationship between management and changes in these costs and benefits is extraordinarily complex. Management actions, or lack thereof, taken in one year affect the growth of native perennial vegetation, woody fuels, and invasive annual grasses over all future years, making the decision-problem of the land manager a dynamic one, and costs and benefits a function of where and when management actions are taken on the landscape level. Wildfire is stochastic, as is vegetation growth rate. Thresholds between ecological states as predicted by state and transition model theory are not perfectly observable until after a wildfire has occurred, and even then there is a time-lag between the year of the fire and the year where it can be determined whether the site has indeed transitioned to a different steady state characterized by more frequent wildfire and less productivity. Similarly, wildfire suppression costs vary depending on the state of the ecosystem, which is partially determined by investments in management activity.

The value of the ecological goods and services provided by rangelands that may be lost due to wildfire and wildfire-induced transitions to less productive ecological states are a function not only of associated changes in ranching productivity, but also a function of recreational uses, effects of erosion and water quality and quantity impairment to downstream watershed populations, losses in biological diversity and other important ecosystem services that are not valued as commodities in the marketplace. For these reasons, an integrated economic-ecological modeling approach is required to estimate economic changes induced by management actions, or lack of actions, designed to influence the role of fire on rangeland landscapes. This paper reports on a research program that incorporates features of state and transition ecological models of rangeland dynamics into a set of economic models. The models are parameterized to describe and predict the cost and benefits of management actions on Great Basin sagebrush rangelands. The models include estimation of wildfire suppression costs, and a stochastic dynamic programming approach to simulate the deviation between optimal choices about grazing and vegetation treatment from the perspective of a ranch-level decision maker and a decision-maker who must take into account additional non-commodity societal values.

[*]University of Nevada, Reno

1001   **Roohr, Peter**[1], Marina Timofeyeva[1], Sher Schranz[2] and Robyn Heffernan[3]

The Availability of NOAA Climate Services and Support for Fighting Wildfires

Abstract: Recent wildfire events have emphasized the importance of merging climate information and wildfire planning strategy. It is extremely important for firefighting agencies to understand and use National Oceanic and Atmospheric Administration (NOAA) climate information available for seasonal and mid-range planning. Conversely, NOAA needs to fully comprehend firefighting agency requirements for short and long range weather information. Many areas of the southern and western United States have undergone dramatic changes in vegetation amount and diversity as well as changes to water bodies and an increasing wildland-urban interface. Influences from precipitation patterns related to La Nina have induced drought over widespread areas. Severe and deadly fires in 2011 have already affected areas west of Denver CO and the grasslands of the Southern Plains. NOAA's National Weather Service (NWS) provides climate products and services that could serve as a resource for wildland firefighting management decisions. NWS provides standardized local climate web pages (www.weather.gov/climate) providing observation record, and national and local forecast products. The Environmental Modeling Center, in collaboration with the Climate Prediction Center, has been maintaining and improving the Climate Forecast System, a fully coupled ocean-land-atmosphere dynamical seasonal prediction system that has been operational since 2004. The NWS Office of Climate, Water and Weather Services Climate Services Division has been working on a Local Climate Analysis Tool, which can perform local drought and severe weather local studies. CSD hosts a Partnership Exchange Program that helps to facilitate the exchange and cross-pollination of ideas and expertise for many customers.

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604 **Roundy, Bruce A.**[*] and Kert Young[*]

Effects of fire and fuel treatments on soil water availability in sagebrush communities

Abstract: Fuel-control treatments that reduce major water-users in sagebrush communities such as trees or shrubs may increase soil water availability for both desirable and undesirable residual species. We measured hourly soil water potential and soil temperatures across the Great Basin on sagebrush communities that were either uninvaded (sagebrush sites) or invaded by pinyon and juniper trees (wooded shrublands). Measurements were taken on plots that were burned, mechanically-treated, or chemically-treated to reduce trees or shrubs and in relation to low to high tree and perennial grass density prior to treatment. Sites were ordered and treatment effects compared for seasonal time of soil water availability (number of days soil at 13-30 cm was wetter than -1.5 MPa), wet degree days (summation of hourly temperatures above 0 ° C when the soil is wet), and soil temperatures. Sagebrush sites were generally drier and warmer than wooded shrublands. Western juniper sites were wetter than pinyon and Utah juniper sites. Pinyon and juniper sites in central Nevada were generally drier and cooler than western juniper sites in Oregon and Utah juniper-pinyon sites in Utah. Reducing trees by fire, cutting, or shredding increased the time of soil water availability in spring more than treatments that reduced shrubs by fire, mowing, or applying herbicide. Soil water availability was increased most on wooded shrublands with higher pretreatment tree densities. Increased soil water availability from tree reduction carries both a benefit of increased cover of desirable understory species, but also a risk of dominance of undesirable weedy species. Communities with a higher cover of desirable species before treatment should have less risk of weedy dominance after treatment.

[*]Brigham Young University, Provo, UT

1206 **Rowley, Allen**[*], Linda Chappell[*] and Robert Campbell

Line Officer Philosophy and Intent: Decision-making on a Large Fire

Abstract: This paper explores foundational information and guiding principles that can mold and shape line officer philosophy for appropriate decisions and actions while managing large wildfires. The Twitchell Canyon wildfire (2010) on the Fishlake National Forest in south-central Utah, which burned for more than 100 days and had nearly 45,000 acres within the fire perimeter, will be used as a case study. Ways to manage and minimize risk will be discussed. Good communication with key contacts is critical to sustain desired objectives throughout the incident.

[*]USDA Forest Service, Fishlake National Forest, Richfield, UT

505 **Sankey, Joel B.**[1], Matthew J. Germino[2], Nancy F. Glenn[3], Jan U. H. Eitel[4], Sujith Ravi[5] and Cynthia SA Wallace[1]

Quantifying biogeomorphic response to fire at micro to biome scales

Abstract: We will present recent research from cool and warm desert rangelands of the western USA that examines post-fire wind erosion and the response of vegetation and soil to fire at microsite, wildfire, and regional scales. The focus of the presentation will be on results from experiments and observations conducted with ground, airborne, and satellite-based remote sensing. At fine spatial scales (1 cm – 1 m length scales), the interacting effects of vegetation succession, fire,

and sediment transport play an important role in the evolution of soil microsites beneath and adjacent to shrub and grass vegetation. Observations with terrestrial LiDAR of increased roughness of the soil surface beneath burned shrubs identified a physical mechanism for the fine-scale, spatial heterogeneity of fire-induced increases in erodibility. At intermediate spatial scales (1-10 km), sediment and nutrient transport link upwind burned area sources to downwind, unburned rangeland sink areas. Using airborne LiDAR, we identified that the effect of shrub vegetation (both burned and unburned) varies in strength between erosion and deposition processes, which in conjunction with measurements of the transport of bioavailable nutrients, highlights the role of fire and wind erosion in nutrient depletion as well as fertilization processes. At much coarser regional geographic scales, wind erosion responses to interannual variability in vegetation phenology are observed in unburned rangelands with remote sensing phenometrics using AVHRR and MODIS satellite imagery. After wildfire, remote sensing phenometrics can be employed to measure the resistance of soil surfaces to wind erosion. Our research findings and methods at each geographic scale have implications and application for rehabilitation efforts in burned rangelands.

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905   **Scott, Joe[1]**, Don Helmbrecht[2] and Sean Parks[3]

Assessing the potential impact wildfires managed for multiple objectives using the FSIM large fire simulator

Abstract: Federal fire and land managers increasingly wish to manage unplanned wildland fires for multiple objectives. Although every wildfire is a potential candidate for multiple-objective management, land managers are specifically interested in assessing the potential downwind impacts of such incidents where they are most likely to occur—in areas relatively remote from valuable, fire-susceptible resources and assets. To support fire management planning, managers need basic information regarding the likely impacts of such wildfires on downwind assets and resources such as residential buildings (the wildland-urban interface). The FSIM large fire simulator has only modest ability to simulate the effects of such a program to manage wildfires for multiple objectives—it includes a suppression module that is either enabled or disabled for an entire landscape simulation. This paper describes a technique to simulate the occurrence, growth and downwind impact of wildfires managed for multiple objectives (WMMO) by strategic adjustment of FSIM's basic inputs and analysis of the FSIM polygon-based fire perimeter results. Analysis inputs include fire climate and fire occurrence of the recent past, the current fuelscape, and guidelines on the conditions under which wildfires may be chosen for MMO (time of year, ERC, and location of fire start). The analysis produces an estimate of the average number of MMO incidents per year in a designated zone, the average size of those fires, the likelihood that those fires will reach a nearby resource or asset, and the average downwind resource area impacted. We apply this technique to a small landscape west of Jackson, WY on the Bridger-Teton National Forest, including the effects of proposed landscape-level fuel treatments.

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1002 **Scott, Joe**[1] and Don Helmbrecht[2]

Techniques for landscape-scale assessment of potential wildfire behavior

Abstract: FlamMap has been used for many years to assess landscape-scale potential wildfire behavior in support of fire management planning. Such assessments typically present geospatial results in cartographic form only, and are based on weather inputs with uncertain relation to the local weather record. In this paper we present techniques for developing meaningful FlamMap weather inputs using an analysis of the weather record using non-spatial tools such as FireFamilyPlus and NEXUS. We also suggest standard classifications of FlamMap outputs that allow comparison of assessments across a wide range of fuel, weather and topographic conditions. Finally, we present a standard chart for summarizing geospatial fire model results over a range of input values.

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1008 **Seielstad, Carl**[*] and Eric Rowell[*]

Frontiers in fuels science: using laser scanners to re-invent fuels characterization

Abstract: The three-dimensional nature of fuels has long been recognized and tools have been developed to translate them into 1-D values or qualitative indicators of fire behavior; only recently have fuel descriptions and fire modeling advanced to the point where 3-D information can be used directly. Nonetheless, distributing real fuels within volumes remains a complex problem. Accurately measuring the 3-D locations of fuel elements in the field is difficult and time consuming; abstracting these measurements to the attributes that new fire models require is challenging. Yet, the three-dimensional point clouds that result from laser scanning lend themselves naturally to production of the cell-based arrays required by new fire models. This paper discusses advances and challenges in laser scanning of fuels, focusing on integration across a range of scales. Results from terrestrial and airborne laser scanning (TLS and ALS) are presented concurrently to demonstrate synergies between the techniques for scaling fuels measurements. In brief, TLS facilitates assimilation of fuel measurements on micro-plots (25 m^2) with measurements from macro- spatial domains (circa 2500 m^2), while ALS makes possible scaling to the fire event domain (1000 ha) via derivation of surface roughness and tree crowns, and through subsequent integration with TLS measurements. The TLS-ALS couplet provides a means of linking surface and canopy fuels systematically while representing spatial variability in both layers. Further, by incorporating pre- and post-fire scans, the location, quantity, and type of fuels consumed can be enumerated.

[*]University of Montana, Missoula

704 **Shanklin, Amber**[*]

Rehabilitation of slash pile scars in Colorado

Abstract: Forest thinning is a common practice used by land managers to reduce fuel loads and to restore historic forest structure and function in Colorado. Typically, the material removed by thinning is unmerchantable and must be disposed of to reduce the risk of crown fires. Slash pile burning is the most widely used technique in this situation due to its cost effectiveness, practicality, and ease of implementation under a wide variety of weather conditions. Despite these factors, slash pile burning causes drastic changes to soil conditions and vegetation

composition, which are a concern for land managers charged with maintaining soil productivity and native plant diversity. The objective of my study is to identify cost effective and practical restoration treatments to mitigate ecological damage and to restore community structure and ecosystem processes within slash pile burn scars in the Front Range of Colorado. We aim to determine simple rehabilitation techniques capable of minimizing soil degradation, promoting native species recolonization, and preventing non-native species establishment within burn scars. Rehabilitation treatments were installed at 20 sites throughout CO's Front Range. The treatments were: scarification, scarification and seeding, wood chip mulch, wood chip mulch and seeding, vertical mulch, vertical mulch and seeding, seeding, and an untreated control. Treatments will be compared to each other, to the control pile (non-mechanically treated), and to the reference condition (outside the pile).

[*]Colorado State University, Fort Collins

1009   **Steffens, Ron**[*]

Seasonal fuel moisture monitoring and climate trends: a 20 year assessment from Grand Teton National Park

Abstract: For the past 20 summers, Grand Teton National Park has conducted a long-term fuel moisture collection and assessment program. During this period we've had wet summers and dry, El Nino and La Nina, beetle-kill and climate change; we've had lightning fires and escaped campfires, PNFs and WFUs, wildland fires and prescribed fires, and now we've focused our terminology on suppression, managed, and monitored fires. Throughout these various fire seasons and fire-policy approaches, we've clipped, weighed, and dried our fuel samples in order to better understand each fire's potential. Fuel moisture sampling offers an interpreted validation of calculated fire indices and projected fire activity; fuel moisture trends also offer site- and season-specific guidance on long-term and landscape-scale fires. On reviewing this process, we've observed that the primary season-to-season objective of managing fires has led us to focus on correlating each month's fuel status to our projected fire activity. Yet we have overlooked an opportunity for long-term calibration of fire activity to our sampled fuel moistures. In our initial efforts to calibrate fuel moistures with fire-season activity, we demonstrate the variability in fuel moistures and also explore a trend toward extended seasons -- which many consider both a marker and result of climate change in the greater Yellowstone ecosystem. But even without such expansive claims, a local fuel moisture history offers the beginning of a database that will allow for further insights into climate, fire, and fuel availability. These and other questions arose as we integrated our fuels monitoring program with the National Fuel Monitoring Database and were better able to compare our observations with adjacent sites. One key question -- how the regional and site-specific impacts of climate change might be reflected in fuel moisture trends? -- offers a case study in how we might better integrate evolving scientific queries into field-based and management-focused monitoring, as well as guidance as we seek to apply 'best available science' to fire management decisions.

[*]National Park Service, Grand Teton National Park, Moose, WY

1202   **Stetler, Kyle**[1], Tyron Venn[1] and David Calkin[2]

The effects of wildfire and environmental amenities on property values in northwest Montana

Abstract: This study employed the hedonic price framework to examine the effects of 256 wildfires and environmental amenities on home values in northwest Montana between June 1996 and January 2007. The study revealed environmental amenities, including proximity to lakes, national forests, Glacier National Park and golf courses, have large positive effects on property values in northwest Montana. However, proximity to and view of wildfire burned areas has had large and persistent negative effects on home values. The analysis supports an argument that homebuyers may correlate proximity to and view of a wildfire burned area with increased wildfire risk. Indeed, when a burned area is not visible from a home, wildfire risk appears to be out of sight and out of mind for homebuyers. Findings from this research can be used to inform debate about efficient allocation of resources to wildfire preparedness, including public education programs, and suppression activities around the wildland–urban interface.

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004   **Tausch, Robin J.**[*] and Cheryl L. Nowak[*]

Vegetation Change in the Great Basin Over Time

Abstract: Arid and semi-arid ecosystems of the Great Basin have been responding to, and adapting to major changes in climate for thousands of years. Both vegetation data, and the associated proxy climate data, document major climate and vegetation oscillations across the Holocene at centennial scales. This sensitivity of Great Basin vegetation to these past climate changes, particularly those in response to drought, have been consistent over the Holocene. It is the vegetation changes associated with the repeated drought cycles has provided important information on the kinds of vegetation changes that are possible in the Great Basin in response to significant climate warming. This includes Holocene examples of elevational shifts in plant species distributions exceeding 3,000 feet. It is in the understanding of the relationships between Holocene climate changes and the associated vegetation changes, interacting with current human driven environmental changes, that it becomes possible to better understand current vegetation changes, and to anticipate the future vegetation changes. The patterns and rates of a three to four times expansion in Great Basin piñon-juniper woodlands over the last 150 years provides an example of the speed and the landscape scales at which the combination of climate, and other human driven environmental changes are currently driving landscape scale ecosystem changes. Similar, and probably greater, changes will continue into the future. It is the combination of the increasing presence of exotics interacting with the climate and environmentally driven changes, and the potential the combination has for the permanent alteration of the affected ecosystems, that presents the greatest challenges for management.

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407   **Teske, Casey**[*], Carl Seielstad[*] and Lloyd Queen[*]

Characterizing Fire-on-Fire Interactions in Three Large Wilderness Areas Using the Monitoring Trends in Burn Severity (MTBS) Fire Perimeter Data

Abstract: Using fire perimeter data from the MTBS dataset, we quantified fire-on-fire interactions for three large wilderness areas in Montana and Idaho from 1984 to present. Although many fire managers presume that scars from older fires generally constrain the spread of new fires (with anecdotal evidence

supporting these assumptions), no studies have systematically addressed these fire-on-fire interactions across large land areas. We analyzed the MTBS fire perimeters to quantify reburns in terms of frequency, size, and time-since-previous-fire. We compared current rates of burning to existing estimates using the natural fire rotation (NFR) to determine whether contemporary rates are within historic ranges. We compared actual and simulated fires to establish whether the frequency and size of reburns is different from chance. To quantify the effect of previous fires on subsequent fire spread, shared fire edges were systematically classified as either fire-stopping or breached. Current NFRs are consistent with results derived from fire atlas and tree-ring research studies. When a new fire encountered the edge of a previous fire, the new fire nearly always burned onto the previously burned landscapes. In general, the reburned areas were small, implying a general resistance of fires to burn in the previously burned areas. Reburn frequency was the same as chance in the Selway-Bitterroot, but less than chance in the Bob Marshall and especially in the Frank Church. As the time between subsequent fires increased, there was a systematic decrease in the frequency of small to medium sized reburns in all three wilderness areas.

*University of Montana, Missoula

007   **Thomas, Dave***

Metaphors Fire Ecologists Use: Observations of An Amateur Anthropologist at the Interior West Fire Ecology Conference

Abstract: It is my task to sit in on as many of the presentations delivered at this fire ecology conference as I can, and then, on the last day, to "sum-up" the conference. This is a standard role played at conferences—someone is asked to give "closing comments." When this talk is over it is nearly time to leave. I am very aware that many people pull out of conferences at this point; after all, it takes a small pinch of will-power to stick around on the last day just to hear a regurgitation of talks you have already listened to yourself. To my mind, it makes good sense to want to hurry home. So with images of some of you scurrying out of the door in mind, I have made a goal for myself to try to "sum-up" this gathering of fire ecologists in a fresh, at least to me, way: Is it possible, I wonder, to see a group of people I have spent over four decades working with, in a new light? To test my hypothesis, I have chosen to approach my assignment in this way: I will pretend that I am I an anthropologist and all the things going on at this conference are part of the culture I was sent to study. This method is not as strange as it may sound; in 1968, the famous American anthropologist, Margaret Mead, and her fellow researcher, Paul Byers, published a study of what they called "the small conference." Organizational psychologists are well aware that one splendid tool useful in cracking the shell of a culture is to monitor that culture's use of metaphors. So, for the whole week, I will be alert to not only the subjects of the individual talks I listen to, but also sensitive to the metaphors each presenter (and their audiences) used to make their points. What might these metaphors say about the culture and work of the field of natural resource management called fire ecology?

*Renovelling, Ogden, UT

506   **Wagenbrenner, Natalie[1]**, Serena Chung[2] and Brian Lamb[2]

Measuring and Modeling Dust Emissions from Soils Burned by Wildfire

Abstract: Recent investigations have shown that wind erosion rates can be large

following wildfires; however, little information is available regarding emission and transport of dust particles and ash from burned landscapes. Quantifying post-fire particulate emissions and transport and dispersion of dust plumes are important for understanding impacts downwind of burned landscapes. A monitoring system was installed following a 2010 wildfire in southeastern Idaho to determine the vertical flux of PM_{10} (particulate matter with a diameter of less than 10 μm) to the atmosphere. Wind tunnel experiments were conducted on soils collected from the burned area to determine wind erodibility parameters for numerical modeling of PM_{10} emissions from burned landscapes. Modeling parameters for burned soils were incorporated into AIRPACT, the regional air quality forecasting system for the Pacific Northwest. This paper compares PM_{10} concentrations observed on-site to AIRPACT-predicted concentrations and compares the predicted plume trajectories to those visible in satellite imagery. The maximum measured PM10 vertical flux was 4283 μg m^{-2} s^{-1}, which is on the upper end of values reported in the wind erosion literature. Results indicate that wildfire can convert a relatively wind-resistant landscape into a strong source of PM_{10} which can degrade air quality both on-site and 100's of kilometers downwind.

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1301 **Washa, Bradley J.**[*]

Hazardous Fuels Treatment Effectiveness on Utah BLM Lands

Abstract: Since inception of the National Fire Plan, numerous hazardous fuels treatments implemented on Bureau of Land Management lands within Utah have been intersected by wildland fire. Hazardous fuels treatment effectiveness can be demonstrated with 52 projects impacted by wildfires. This has reduced the size of unplanned ignitions, assisted in providing opportunities to stop or slow the spread of the wildfire, provided for greater firefighter safety, allowed for opportunities to manage unplanned ignitions for resource benefits, reduced the burn area rehabilitation needs and costs, and allowed for greater resiliency of the environment in returning to a functional ecosystem following a wildfire.

[*]Bureau of Land Management, Utah State Office, Salt Lake City

501 **Williams, C. Jason**[*] and Frederick B. Pierson[*]

Hydrologic and Erosional Impacts Associated with an Increased Role of Wildland Fire on Western Rangelands

Abstract: Landscape plant community transitions across the Great Basin and Intermountain West have altered fire regimes and present large-scale consequences relative to rangeland hydrology. Extensive conversion of Great Basin shrub steppe to annual grasslands has increased fuel continuity and the frequency, size, and severity of wildfires within these systems. Densely stocked persistent woodlands and wooded shrublands have experienced an increased frequency of large, high severity fires resulting in part to greater fuel loading. The increased role of fire amplifies the spatial and temporal exposure and vulnerability of these landscapes to greater runoff and erosion. Greater temporal exposure ensures significant runoff and long-term soil loss from frequently occurring low interval storms (1-10 yr events) and increases the likelihood that susceptible conditions will occur during less frequent, more damaging flood-generating storms. Historical accounts of post-fire flooding, resource damage and loss of human life further demonstrate the potential risks associated with an increased

frequency and severity of wildland fire. This study explores the hydrologic impacts of large-scale plant community transitions and an increased role of wildland fire on western rangelands. Potential fire effects on rangeland hydrologic vulnerability are presented through a review of published field studies from semi-arid rangelands and woodlands and xeric forest communities. A conceptual framework for evaluating post-fire hydrologic response and risk is presented. Our geographic focus is the Great Basin and Intermountain West, but the concepts presented are likely applicable across the western US where ongoing plant community transitions have increased the role of wildland fire.

[*]USDA Agricultural Research Service, Boise, ID

1305   **Woolley, Travis[*]**, Dave Shaw[*] and Stephen Fitzgerald[*]

Lodgepole pine forests following mountain pine beetle epidemics: A chronosequence of fuels and potential fire behavior for south-central Oregon

Abstract: Mountain pine beetle (*Dendroctonus ponderosae*) (MPB) has caused extensive lodgepole pine mortality in south-central Oregon, peaking at over 1,000,000 acres of mortality in 1986 and over 500,000 acres in the past decade. This widespread mortality from MPB has raised questions about the potential for catastrophic fire. A lack of data and equivocal research results about how MPB caused mortality influences temporal and spatial aspects of fuels and potential fire behavior, limits the ability of fire managers to determine when and if fuels treatments will be effective. In addition, lodgepole pine forests in south-central Oregon are ecologically unique (e.g., low cone serotiny, primarily climax lodgepole pine communities) compared to other extents of the species' range. Using a chronosequence approach, we address the following questions in south-Central Oregon to directly aid forest mangers on the Deschutes and Fremont-Winema National Forests: 1. How do fuel profiles (ground, surface, ladder and crown fuels) in lodgepole pine forests change over time in response to MPB epidemics in south-central Oregon? 2. What are the effects of MPB epidemics on future fire behavior and how does fire behavior change over time following the epidemics? Our data will be used to reconstruct ground, surface, ladder, and crown fuel succession following MPB epidemic (i.e, developing a chronosequence). To model and estimate the temporal and spatial change in potential fire behavior we will use standard fuel models or, if necessary, custom fuels models from our collected data, in conjunction with fire behavior algorithms in BehavePlus v 4.0.0, FlamMap, and FARSITE.

[*]Oregon State University, Corvallis

608   **Young, Kert[*]** and Bruce Roundy[*]

Mechanically shredding Utah juniper and soil environment characteristics

Abstract: Juniper species are taking over thousands of hectares of sagebrush steppe. In the absence of fire, juniper density increases thereby decreasing understory vegetation while increasing canopy fuel loads and the potential for catastrophic wildfire. To reduce canopy fuel loads, the Bureau of Land Management is mechanically shredding Utah juniper on hundreds of hectares annually in Utah. The expectation is that converting canopy fuels into surface fuels will reduce the rate of fire spread and allow better control of wildfire. Juniper is shredded by a large rotating drum with hardened spikes that is mounted on a large articulating tractor. This treatment leaves patches of shredded fuels over preexisting canopy litter and interspace soil. Little research has evaluated the

effects of juniper mastication on the micro-climate and soil nutrient conditions created by mastication upon which plant species depend for survival. The primary objective of this study was to determine how juniper mastication changed the soil environment and nutrient characteristics at the microplot level. Trees were shredded at 3 locations in Utah. Within treatment plots, the study was a randomized complete block design. At each location, we measured soil moisture, temperature, C, N, and organic matter in microplots of canopy litter, juniper shreds, and interspaces. Juniper litter microplots were associated with increased soil nutrient concentrations in both the shredded and untreated control plots. Juniper shredding was generally associated with improved soil moisture and temperature conditions for plant growth, which might be beneficial for plant establishment.

*Brigham Young University, Provo, UT

1205   Zimmerman, Thomas* presented by **Kim Ernstrom**

Opportunities for Change and Influence within the Framework of Wildland Fire

Abstract: Wildland fire management has historically been a challenging and complex program. During the last 25 years a rapidly changing fire environment, increasing diversity in land use objectives, emergence of multiple strategic objectives for individual fires, and an expanding range of both possible and necessary tactics have further compounded program complexity. Wildland fire management is framed by a number of elements that affect its scale, scope, strategic direction, planning focus, and implementation activities. These factors are part of an overall framework that begins with broad direction and progresses through guiding principles, coarse scale goals, policy, program mission, and into specific wildland fire management program direction. Linkages among these framework elements are critical to ensure that program implementation at the ground level is consistent with overarching principles, policy, and land and resource management plan decisions and strategic objectives. While program complexity and challenges will continue to increase, opportunities are available to respond to these challenges and influence change in the future. Possibilities exist to influence policy formulation; land and resource management and fire management planning direction and activities; and implementation procedures, practices, and activities. Input into these areas must be inclusive of current and future situational variables such as emerging science and technology; changing land use practices; social, economic, and political concerns and needs; ecological considerations; climate change interactions with the fire environment; invasive species proliferation; fire management strategies; tactical options; and bounds on tactical implementation. This presentation describes the wildland fire management framework and identifies opportunities to work within that framework to influence change, program direction, modernize fire management, and improve land and resource management.

*USDA Forest Service, Wildland Fire Management RD&A

7   **Andrews, Garren**[*] and Christopher Dicus[*]

Post-fire response in a coastal redwood/Douglas-fir forest, Santa Cruz Mountains, California

Abstract: We investigated how fire severity impacts the survival and response (sprouting/seeding) of multiple species in the Santa Cruz Mountains of coastal California, including coast redwood (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga menziesii*), tanoak (*Lithocarpus densiflorus*), and Pacific madrone(*Arbutus menziesii*). During August 2009 the Lockheed fire burned nearly 3,160ha of mixed-conifer stands with variable severity. Data from 37 Continuous Forest Inventory (CFI) plots were collected immediately before and for 2 successive years following the 2009 Lockheed Fire. This research entails three objectives. First, we quantified post-fire mortality of trees that vary in species, size, and fire severity. Second, data was quantified for post-fire response (sprouting, seeding) of those four tree species in areas of varying fire severity. Third, we developed logistic regression models that predict post-fire mortality and response for each of the four species. Understanding the relationship between burn severity, mortality and regeneration can allow for better post-fire predictive services. This research can support forest managers in determining the best management practices to facilitate long-term sustainability and protection of environmental infrastructure within coast redwood/Douglas-fir forests.

[*]California Polytechnical Institute, San Luis Obispo

3   **Clark, Jason A.**[1], Rachel A. Loehman[2] and Robert E. Keane[2]

Reducing ecosystem vulnerability through management treatments under potential future climate change conditions: An experimental framework for incorporating simulation models into decision-making frameworks

Abstract: Climate projections for the next 100 years forecast higher temperatures and variable levels of precipitation in the western United States, with associated changes in carbon budgets, wildfire intensity and severity, shifts in species composition and distributions, and available wildlife habitat. As land managers and researchers address the impacts of climate changes, they are forced to confront the mismatch of temporal and spatial scales among broad-scale ecological processes and local site-specific actions and studies. For example, although climate changes operate across landscapes continuously over a very long time period, management actions are often periodic and implemented at fine spatial scales. Furthermore, because effects of climate changes on ecosystems are often very complex and operate across taxa and scales, land management policy is challenged to craft mitigatory strategies that fully account for these complexities. Our landscape is Yellowstone National Park, USA. We used the mechanistic simulation model FireBGCv2 to explore potential effects of three climate regimes (current climate, warm-wet, and hot-dry scenarios) coupled with existing management treatments on landscape vulnerability. We assessed vulnerability in terms of sensitivity, exposure, and adaptive capacity relative to three response categories: carbon storage, wildfire patterns, and biodiversity. We then constructed a set of treatments designed to minimize exposure, reduce sensitivity and improve adaptive capacity of landscape elements to the range of simulated

climate conditions. These results will be used in cooperation with land managers to develop a refined suite of management actions that reduce vulnerability and maximize climate change adaptation. The study offers a new perspective on future forest and fire conditions in Yellowstone National Park.

[1]Yale University, New Haven, CT; [2] USDA Forest Service, Rocky Mountain Research Station, Missoula, MT

8   **Comfort, Emily**[*] and John Bailey[*]

The implications of fuel heterogeneity at management boundaries for fire behavior and wildlife habitat in the Elk Creek Watershed, Oregon

Abstract: In a multi-ownership landscape with a diverse array of land management goals, the spread of wildfire from one stand to the next is a management concern. The structure and composition of fuel at stand boundaries will have a meaningful impact on the rate of spread and change in behavior of fire from one stand to the next. This study will quantify changes in fuel character at multiple scales across stand boundaries in order to determine if there are optimal management techniques for reducing the rate of spread and intensity of wildfire at small scales at the intersection of stands with multiple management objectives. The results will be used to determine larger-scale management implications for fire risk and wildlife habitat management in the landscape I expect that larger differences in structure and composition at management boundaries between private industrial timber plantations and forest reserves on public land will have the largest differences in fire behavior (Omi and Kalabokidis 1991). Stands that are similar in composition and structure are also likely to have similar fuel loads and arrangements and therefore, smaller changes in fire behavior. Fire behavior calculations are in development for full analysis, but summaries of fuel characteristics measured in the field have shown that there may be some interesting differences in fuel load and character at stand boundaries under different ownerships. These differences will also be used to identify which types of boundaries are used more frequently by Northern Spotted Owls using telemetry data.

[*]Oregon State University, Corvallis

20   **Corrow, Allissa L.**[1] and David L. R. Affleck[2]

Double Sampling Application to Line Intersect Sampling for Coarse Woody Debris Inventories

Abstract: Quantification of coarse woody debris (CWD) provides a useful metric for assessing wildlife habitat, fuel loading, and more recently, carbon sequestration. Recently, many novel sampling methods have been introduced, but accurate estimation remains difficult and expensive. The diversity of sampling methods coupled with the highly variable estimates may confound the ability to track the temporal carbon flux in national and global carbon budget efforts. Double sampling is an approach that exploits the correlation of two variables through regression estimation, and allows for increased precision or decreased sampling cost. The present study investigated the application of double sampling to the line intersect sampling (LIS) method to estimate aggregate volume and abundance of CWD in conifer stands of western Montana. We found that while double sampling can be a valuable tool for estimating other forest attributes (e.g. standing tree volume), the inherent variability of CWD in our study area requires a substantial difference in cost to sample the two variables. Further research may indicate that stratification by particle size, or sampling via remote sensing will

allow for double sampling as a means of reducing sampling costs and increasing estimation precision.

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9   **Dean, Alison E.**[1], Geoff Babb[1], Deb Mefera[2], and Bryan Scholz[3]

Coyote Hills: An adaptive management case study

Abstract: In 2009, Central Oregon Fire Management Service (COFMS) incorporated an adaptive management loop into its burn plan template, and subsequent burn projects have experienced improvement in collaboration, trust, and procedural efficiency. A pair of projects on the Crooked River National Grassland exemplifies this process. In August 2010, the 1500-acre Cemetery-Healy burn incorporated some atypical treatments. Monitoring was done to gauge effectiveness. Post-burn contention between fuels and range specialists was due to the unsuccessful avoidance of small patches of Medusa Head (Taeniatherum caput-medusae). In May 2011, an after-action review that included a line officer, fire ecologists, fuels staff, and resource staff was held at the burn unit. The discussion of lessons learned at Cemetery was used to develop goals for the adjacent 2400-acre Coyote Hills unit where there is a greater presence of Medusa. A subsequent interdisciplinary fieldtrip built consensus in defining project objectives, constraints, data needs, and opportunities for monitoring. The team agreed to try a variety of treatments in order to learn how better to prevent spread of the invasive species in future projects. Details of the collaborative process, monitoring design, and burn implementation will be shown in this poster.

[1]Bureau of Land Management, Prineville District, Prineville, OR; [2]USDA Forest Service, Deschutes-Ochoco National Forests, Prineville, OR; [3]USDA Forest Service, Crooked River National Grassland, Prineville, OR

10   **Droske, Christine**[1], Penelope Morgan[1], Peter R. Robichaud[2], Sarah A. Lewis[2] and Anthony Davis[1]

Tree Seedling Density and Height Growth Following Post-fire Salvage Logging and Grass Seeding in Mixed-Conifer Stands on the 2005 School Fire, Washington, USA

Abstract: Western forested landscapes have been shaped by the interplay of fire, succession, and active management, yet these complex interactions are poorly understood. In 2005, the School Fire burned approximately 21,000 ha through a variety of terrain and fuels, resulting in a mosaic of burn severities across the Pomeroy District of the Umatilla National Forest. Some of these areas were subsequently salvage logged and/or seeded with native grasses. We measured density and height growth rates of *Pinus ponderosa*, *Pseudotsuga meniezsii*, *Abies grandis, Pinus contorta, Larix occidentalis* and *Picea engelmannii* seedlings in 2011 on 56 randomly located plots to test the hypothesis that post-fire salvage logging and seeding with native grasses influenced the response to low, moderate and high severity burns. According to our preliminary results, tree seedling density and height growth were reduced on high severity burns relative to moderate and low severity burns, especially when the sites had been both salvage logged and seeded. Areas that burned under high severity may have less available soil moisture than those areas that burned less severely, which could be further reduced by salvage logging impacts and competition from grasses seeded in abundance. We measured pre dawn moisture stress of individual *Pinus ponderosa* seedlings and soil moisture in representative sub plots within each treatment. Our results will inform these widely applied and often expensive treatments by

providing data on the potential impacts to developing stand density and growth rates.

[1]University of Idaho, Moscow; [2]USDA Forest Service, Rocky Mountain Research Station, Moscow, ID

28   Farahi, Ehsan[*] and **Mehrdad Ghodskhahe Daryaei[*]**

Risk zone mapping of forest fire using GIS and AHP in Guilan province

Abstract: Forest fires, as an ecological risk, whether with human or natural origin, have profound effects on land cover, land use, production, local economies, global trace gas emissions, and health. Identification of factors affecting the existence of forest fire as well as its zonation in the given watershed is one of the basic tools for forest fire control and fighting action. The aim of this research is to develop the forest fire risk map based on vegetation , physiographic and climatic factors, human, distance to rivers and roads, in a part of Guilan forests. For this purpose, digitally diffusion forest fires map with field checks using GPS were prepared, initially. Then affecting factors were binary compared using Analytical Hierarchy Process (AHP) method by indicating the weight of each factor as indicator for their effects in occurrence of forest fire. Accordingly, the forest fire zonation risk map was prepare using weighted information layers and weighted coefficient of each factor. Five categories of forest fire risk, including very high to very low, were derived, automatically. The mapping result of the study area was found to be in strong agreement with actual fire-affected site. The results indicate that the 90% of burned area are located in high risk class.

[*]University of Guilan, Iran

27   **Freeman, Jon[1]**, Diane Abendroth[1], and Martha Williamson[2]

Do we know what we're doing? Articulating and monitoring wildfire objectives.

Abstract: A line officer, coordinating with their resource and fire management staff, makes the decision to manage a naturally-caused wildfire. Objectives for this fire are based on land management plan direction, which can range from "allowing fire to play its natural role" to "improving wildlife habitat." Does this scenario sound familiar? Despite the simplicity and loftiness of this purpose, these "objectives" are not specific, measurable, attainable, realistic, or time-sensitive. Managers should focus on creating "S.M.A.R.T." objectives and assessing whether they are met when making the decision to manage wildfires. Monitoring should be used to show the short and long term results of fire decisions, and detect unforseen consequences. Monitoring the effects of unplanned fires does not have to be complicated or expensive. This poster provides a framework for basic and targeted monitoring that addresses a fire's resource objectives and concerns. It shows that it is possible to formulate concrete objectives, monitor them using remote sensing and basic field measures, and report the results so we can say that, in fact, we do know what we're doing.

[1]National Park Service, Bridger-Teton National Park, Moose, WY; [2]USDA Forest Service, Bridger-Teton National Forest, Jackson, WY

11   **Ghodskhahe Daryaei, Mehrdad[*]**, Mohadese Sedighi[*] and Mehdi Heidari[*]

The effect of fire on some chemical properties of forest soil in Guilan province (Case study: saravan)

Abstract: Fires have considerable effects on biogeochemical properties of forest soils. Fire could change soil nutrient elements which may affect forest soil fertility

through the time, whereas soil is considered as a base for forests growth and regeneration , study of fire effects on its properties takes an important place. The study was carried out in autumn 2010 and the objective of this research was to compare the effect of fire on some soil chemical properties in surface soil (0-30 cm depth) in a forest stand that was burned in 2006 in an area of 8 ha. A control stand with similar conditions was selected beside of the burned area. At each plot, five profiles were dug and from three depths of each profile, soil samples were collected. Results showed significant effects of fire on most chemical attributes of surface soil including: PH, available phosphorous, electrical conductivity and available potassium increasing. The fire caused increasing of total nitrogen and cation exchangeable capacity in surface soil. All of chemical properties of subsurface soil were measured higher in burned area than control however; these differences were not significant, statistically.

[*]University of Guilan, Iran

1   **Goodwin, David**[*] and Leda Kobziar[*]

Soil carbon efflux response to prolonged prescribed fire management in the Red Hills

Abstract: Forests have been recognized at the global scale for their importance in sequestering carbon. This ecosystem service has been identified as a possible revenue stream for landowners who seek to manage forests for wildlife conservation or selective harvesting. The old-field forest type of the 'Red Hills' region of North Florida and South Georgia is the dominant forest type found on a collection of large plantation properties that are primarily managed to promote Northern Bobwhite quail. Previous and ongoing research in old-field carbon dynamics has quantified aboveground carbon pools across multiple prescribed fire management regimes. Little is known however about the effect of prescribed fire management on soil carbon dioxide fluxes. To address this need, this study measured soil carbon respiration rates monthly at two prescribed fire intervals (1yr and 2yr) and a long unburned (> 40 yrs.) control for a period of two years. Effect of season, soil moisture, soil temperature, stand composition, and meteorological conditions were assessed.

[*]University of Florida, Gainesville

35   **Heinsch, Faith Ann**[*] and Patricia L. Andrews[*]

Use of fire danger Fire Characteristics Charts for fire planning

Abstract: The fire characteristics chart created for the U.S. National Fire Danger Rating System (NFDRS) is a graphical method of presenting the indices Spread Component (SC), Energy Release Component (ERC), and Burning Index (BI) by plotting them as a single point on the graph. A related chart presents surface or crown fire behavior characteristics. A desktop computer application has been developed to produce fire characteristics charts for both fire behavior and fire danger. Fire danger fire characteristics charts can be useful for fire planning applications, including fire danger operating plans, prescribed fire plans, and fire management plans. The NFDRS indices represent seasonal changes in fire potential. They are relative indices whose interpretation is based on an analysis of historical data. The fire characteristics chart is a visual representation of indices, providing a means of comparing years, seasons, fuel models, and weather stations. The fire characteristics chart program does not calculate fire danger indices, but rather displays values obtained elsewhere. Indices produced by FireFamilyPlus can be imported directly into the fire characteristics chart program. The program

offers options that allow formatting to suit the application at hand. A user can, for example, change axis scales, use multiple colors, and add point labels and legends. We demonstrate the fire danger fire characteristics chart using examples of fire planning applications.

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29   **Hoffman, Chad[1],** Penny Morgan[2], Ruddy Mell[3], Russell Parsons[4], and Eva Strand[2]

Numerical simulation of crown fire hazard following bark beetle-caused mortality in lodgepole pine forests.

Abstract: While it is widely believed that severe insect infestations likely increase the potential for extreme fire behavior, little scientific information exists to support or refute this idea. Most studies conducted on this topic have relied on operational fire behavior models to simulate potential effects of the altered fuels complex. However these models have inherent assumptions which cannot describe complex fuel arrangements such as those created by disturbances like mountain pine beetle outbreaks. Physics based models do not assume fuel homogeneity within or across stands and account for fire-fuel and atmospheric interactions and thus may provide an alternative to the use of such operational models. The objectives of this study were to investigate how changes in the fuels complex caused by increasing MPB-induced tree mortality interacts with differences in within stand properties and spatial point patterns to affect crown fire hazard through time using the Wildland-Urban-Interface Fire Dynamics Simulator (WFDS). We found that the level of canopy fuel consumption and fire intensity are positively related to increased MPB severity during the red stage. During the grey stage we found that moderate levels of MPB-mortality result in increases in crown fuel consumption and crown fire intensity. We further found that surface fire intensities increase for moderate and high levels of MPB-mortality during this stage. Overall our results suggest that the effect of MPB caused mortality on fire hazard is a function of outbreak severity, the within stand properties and spatial arrangement of overstory trees as well as the time since outbreak.

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18   **James, Laurel***, Ernesto Alvarado* and Daniel Schwartz*

National to Local: a Pre & Post Assessment of FCCS Landscape Variables for CSKT

Abstract: A modified Fuel Characteristic and Classification System (FCCS) fuelbed was created for the Confederated Salish & Kootenai Tribes of Montana. This crosswalk of data combined locally available Continuous Forest Inventory Data (CFI) in combination with the national LANDFIRE data sets. LANDFIRE and FCCS were chosen due to the 30m, high resolution, nationally consistent coverage that would allow for continuous updates and compatibility with other USFS fire and management tools.

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4   **Kitchen, Stanley[1]**, Steven Petersen[2] and Sam St. Clair[2]

Mixed Aspen-Conifer Post-Fire Succession: the Twitchell Canyon Fire as a Long-Term, Variable Severity Case Study

Abstract: Post-fire succession for mixed aspen-conifer landscapes of the North American Interior West is poorly understood, thus studies that examine vegetation

patterns across a range of fire severity classes are needed. In 2010, the Twitchell Canyon Fire burned 18,160 ha on the Tushar Mountains in southwest Utah. The fire burned for 90 days, creating a spatially-variable burn severity mosaic. Fire severity was estimated at 20, 34, and 33 percent for low, moderate and high severity, respectively. In 2011 we measured vegetation attributes on 47 permanent plots. Plots were randomly located within 1,600 m of usable roads and stratified by forest type and burn severity using GIS-based data layers. Attributes were measured for all trees within 15 m of plot centers (0.07 ha). Within each plot, understory species frequency and aspen shoot density were determined using three circular subplots (0.0064 ha). Across all forest types, low, moderate and high frequency fire caused 36, 65, and 100 percent first-year mortality of mature (min. dbh 10 cm) live trees, respectively. Mean post-fire densities were 435 and 171 live trees per ha for low and moderate burn severity classes. Aspen shoots were counted on 38 of 47 plots. Across all plots, mean shoot density was 20,193 per ha. As expected, the understory was dominated by root sprouters and disturbance-adapted herbs. Conifer seedlings were common but not abundant. We anticipate that in time this study will inform improved trajectory and rate predictions for post-fire succession in mixed aspen-conifer communities of the North American Interior West.

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30   **Loehman, Rachel[1]**, Linda Joyce[2], Nick Crookston[3], and Robert Keane[1]

Scales of inference, uncertainties, and key results from an intercomparison of three vegetation-fire simulation modeling platforms in Yellowstone National Park, USA

Abstract: Climate change projections, key drivers of ecosystem models used to forecast and plan for potential future climate-landscape interactions, are inherently uncertain – projections of future climates are influenced by current and future social choices on emissions, and each of the 20-plus climate modeling groups represents the physics of climate in slightly different mathematical expressions. When these climate projections are downscaled to the spatial scales of interest to resource managers, additional uncertainty is introduced. Assessment of effects of climate change on natural resources is of great interest to managers and decision-makers, who may rely on output from a variety of ecological models such as plant bioclimatic profile models, landscape-scale ecosystem process models, and dynamic vegetation models to quantify and respond to potential future landscape-climate interactions. There have been few comparisons in the larger scientific community of the results of these varying types of ecological models. Here we compare key results for three vegetation-fire simulation modeling platforms: FireBGCv2, MC1, and Climate-FVS, in a long-term simulation experiment in Yellowstone National Park, Wyoming, USA. Our results demonstrate key differences in wildfire patterns, vegetation responses, and landscape carbon balance that result from fundamental differences in model design, sensitivity, and process scales.

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12 **Madsen, Matthew[1]**, Stanley Kostka[2], Aaron Inouye[3], and Daniel Zvirzden[3]

Innovative Use of Seed Coating Technology for the Restoration of Soil Hydrology and Wildland Vegetation in Post-fire Water Repellent Soil

Abstract: In semi-arid environments, soil water repellency can contribute to reseeding failure by reducing soil moisture availability and site stability. Non-ionic soil surfactants (wetting-agents) have been shown to be effective in ameliorating soil water repellency; however, their application in wildland ecosystems can be logistically and economically prohibitive. In this study we evaluated an economical and innovative solution for applying soil surfactants using seed coating technology. The objectives of this research were to 1) establish the efficacy of a surfactant seed coating (SSC) in ameliorating soil water repellency within the seed's microsite, and 2) determine the influence of SSC on seedling emergence and plant survival. To accomplish the first objective, detailed soil column experiments were conducted in the laboratory, on water repellent soil obtained from a burned pinyon-juniper woodland. Upon the same soil, the second objective was met through greenhouse testing of SSC on crested wheatgrass and bluebunch wheatgrass seed. Results indicate that SSC increased soil infiltration, percolation, and moisture retention. This technology had no influence on seedling emergence for crested wheatgrass but SSC improved bluebunch wheatgrass emergence threefold. Plant survival was dramatically improved by the SSC. At the conclusion of the study, the majority of the emerged non-coated seeds had desiccated, while 37 % of the plants survived in the SSC treatment. Overall, these results indicate that it may be plausible for SSC(s) to improve post-fire reseeding success. Future research is needed to confirm these findings in the field, to determine if this technology should be recommended as a post-fire restoration treatment.

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21 Martin, Charley[1], Tobin Smail[2], Jim Napoli[2]

Keeping Up With the Changing Landscape in Wildland Fuels (LANDFIRE Total Fuel Change Tool a Practical Method for Fire and Fuels Managers)

Abstract: Since 2005 when LANDFIRE provided the first national layers of vegetation and fuel data, the scale and discrepancies within the data have made it difficult for analysts and fire managers to use. In an effort to better serve the users, the LANDFIRE Project Fuel Team set out to "calibrate" the national fuels layers with local expert input. Through a sequence of workshops across the nation many fuel specialists were engaged with the rectification of the fuel data and through that process a tool was developed to facilitate those changes. The tool, known as LANDFIRE Total Fuel Change Tool or LANDFIRE ToFuΔ, installs as a tool bar in ESRI Arc Map. The user can easily make changes to LANDFIRE fuel data based on the existing vegetation type (EVT), existing vegetation cover (EVC), existing vegetation height (EVH), and biophysical setting (BPS), which are all downloadable from landfire.gov. Since the beginning of its development, LANDFIRE ToFuΔ has been requested by many fuels and fire specialist to assist them in making changes to the fuel characteristics. These changes can occur on specific sites or for entire LANDFIRE map zones and provide for fire planning and real time fire movement across the landscape.

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13   **Moghaddas, Emily**[1], Kevin Grady[2], and Ken Hubbert[3]

Post-wildfire restoration treatments – impacts to soil nitrogen and surface runoff chemistry

Abstract: The 2000 Storrie Fire (Lassen National Forest, northern Sierra Nevada) presented an opportunity to evaluate the effects of post-wildfire management treatments on ecosystem processes and properties. We compared changes in soil processes between untreated burned stands and a range of management treatments within an area burned by a high severity wildfire. Eight post-fire treatments were selected: high severity wildfire with no treatment, low severity wildfire with no treatment, salvage (seedlings planted), plantation (salvage followed by intensively managed plantation), brush mastication, fall burn of grapple piles (dry fuels), spring burn of grapple piles (wet fuels), grapple pile (disturbance area between piles). Field measurements included: soil total CO_2 efflux, net N transformation rates, soil total C and N, forest floor biomass, C and N, soil temperature, soil water content, bulk density, and overland flow chemistry. During the growing season, net N mineralization rates were related to treatment effects on the soil microclimate. High mineralization rates were found in the burned grapple piles, which were well correlated to both high soil temperatures and water content, though also likely attributable to a post-burn nutrient pulse. Similarity between other treatments in net N transformation rates suggest that the availability of N is moderated both by C quantity and quality for microbial metabolism as well as treatment effects on the soil microclimate. Overland flow values for NO_3, PO_4, and SO_4 were near levels found in rainfall chemistry for the northern Sierra. Better understanding of changes in ecosystem processes following post-fire treatments will help managers meet post-wildfire restoration goals.

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23   **MontBlanc, Eugénie**[1], Mike Pellant[2], Jeanne Chambers[3], and Brad Schultz[4]

The Great Basin Science Delivery Project

Abstract: The Great Basin Science Delivery Project assists field-level land managers in identifying and accessing the best fire and resource science information available. The goal is to improve technical and policy decision-making through enhanced communication and information sharing. This project is part of the Joint Fire Science Program's national network of regional knowledge exchange consortia that were initially established in 2010 to address current challenges in fire and fuels management due to increased land use, invasive species, shifting climate, and complexities with differing agency missions and policies. To determine specific technical information and delivery needs for the Great Basin, the Science Delivery Project conducted a needs assessment of 111 federal land management agency personnel in Nevada, Utah, Idaho, and Oregon. Land managers requested information syntheses, online training, a web-based clearinghouse of information, networks of experts, and field workshops. To address these needs, the science delivery project sends quarterly newsletters and email updates about fire and resource science information and events, has established a website and a list serve, hosted five webinars and two workshops, and has developed an interagency restoration cadre. We expect public and private land managers to benefit from this project by having a place and a person to turn to for answers to technical questions, leads to research contacts, and a forum to

communicate technical needs. We expect research scientists to benefit from this project by gaining new ideas and funding sources for research, and by providing new methods of outreach for their research results.

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31 **Morgante, Anna**[*], Christopher Dugaw[*], and Morgan Varner[*]

Incorporating spotting into a simple fire perimeter model

Abstract: Predicting the behavior of a fire which begins to spot can be very difficult for managers. A simple, deterministic, mechanistic model for predicting the perimeter of a fire with active spotting will be a quick and valuable field tool for use in management. This model builds upon established biological invasion theory known as the coalescing colony model. The model will incorporate other established, mechanistic, fire behavior models to predict the perimeter of a fire as it grows by diffusion and coalescence with small spot fires ahead of the front. Elliptical growth models the overall spread of the perimeter of both the main fire and the spot fires. This quantitative, predictive field tool may also be used to determine conditions for which spotting significantly affects the overall spreading behavior of a fire. As a simple model, inclusion into existing simulation and model packages will be simple.

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22 Peppin, Donna[1], **MontBlanc, Eugénie**[2], Andrea Thode[3] and Barbara Wolfson[3]

The Joint Fire Science Program's Knowledge Exchange Consortia

Abstract: Funded by the Join Fire Science Program, a nationwide fire science delivery network of eight Consortia are currently facilitating information transfer within regional fire science communities as well as nationwide. These Consortia are designed to accelerate the awareness, understanding, and adoption of wildland fire science information by federal, tribal, state, local and private stakeholders within ecologically similar regions. For more information visit www.firescience.gov/JFSP_Consortia.cfm. New Consortia: Six new consortia are in the planning phase. Needs assessments are currently being conducted in the following regions: Hawaii (cgiardina@fs.fed.us), Northern Rockies (vwright@fs.fed.us), Oak Woodlands (kgrabner@usgs.gov), Pacific Northwest (janean.creighton@oregonstate.edu), Short Grass Prairie (david.engle@okstate.edu), and Tall Grass Prairie (phzedler@wisc.edu).

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32 **Peterson, Laura**[1], Linda Chappell[1], Kevin Greenhaugh[2], and Chris Bremer[3]

Fire effects of Ponderosa pine following prescribed fire

Abstract: Fire effects monitoring can effectively evaluate burn plan objectives and create recommendations for future management actions. Pre-burn and post-burn assessments of fuel loading, aspen regeneration, tree species composition and density show significant changes post-fire. Our monitoring data from the Puma prescribed burn on the Dixie National Forest shows a reduction in fuel loading, a decrease in white fir within the Ponderosa pine stands and an increase of browsed aspen suckers post-burn.

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2   **Restaino, Joseph[1]** and David L. Peterson[2]

Wildfire and fuel treatment effects on carbon storage, eastside Cascade Range, Washington, USA

Abstract: Sequestration of carbon in forests has the potential to mitigate effects of global climate change by offsetting future emissions and greenhouse gas concentrations in the atmosphere. In dry temperate forests, however, wildfire is a natural disturbance agent with the potential to release large fluxes of carbon into the atmosphere. Climate-driven increases in wildfire frequency, extent, and severity are expected to increase the risks of reversal to carbon stores and affect the potential of dry forests to sequester carbon. Fuel treatments that successfully reduce surface fuels in dry forests can mitigate the spread and severity of wildfire, while reducing both tree mortality and emissions from wildfire. However, heterogeneous burn environments, site-specific variability in post-fire ecosystem response, and uncertainty in future fire frequency and extent complicate assessments of long-term (decades to centuries) carbon dynamics across large landscapes. Results of studies on the effects of fuel treatments and wildfires on long-term carbon retention across large landscapes are limited and equivocal. In this study, we use spatially explicit fuel maps (Fuel Characteristic Classification System) on the Okanogan-Wenatchee National Forest and empirical data on fuel treatment interactions with a large wildfire (Tripod Complex Fire, 2006) to quantify a range of wildfire effects on carbon pools at a high resolution (25-m) across a large spatial scale (105 ha). We summarize short-term carbon fluxes associated with fuel treatment application and the Tripod Fire and track carbon stores temporally across fuel strata, forest type, and burn severity. We also explore a broad range of management and disturbance scenarios to address how fuel treatments at various intensities and intervals affect carbon storage across a range of future fire frequency and severity. Preliminary results suggest that initial net carbon losses may exceed reduced wildfire emissions, and the benefit of fuel treatments to long-term carbon sequestration in dry temperate forests is marginal. Relative differences in carbon storage between multiple future management and disturbance scenarios are summarized.

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26   **Ryan, Colleen[1]** and Eva Strand[2]

Learning to Predict Vegetation Change: a Step-wise Progression for Acquiring State and Transition Modeling Skills

Abstract: Understanding the relationships between vegetation dynamics and disturbance processes can challenge today's land manager. State-and-transition modeling using the Vegetation Dynamics Development Tool (VDDT) and Path software has proven to be useful for natural resource professionals in addressing a wide range of questions related to forest and rangeland management, fuels planning, wildlife habitat management, and ecosystem carbon modeling. The LANDFIRE project has developed a set of vegetation dynamics models for U.S. ecosystems using the VDDT software. These models distill ecological knowledge provided by thousands of local experts, offering valuable information for resource managers, who can adapt these models to address a range of resource

management questions. To facilitate this process, the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT) is developing a set of online courses to assist users in learning to create, modify, and use vegetation dynamics models with the new Path modeling software. These courses will be organized into a "learning pathway" that will begin with basic modeling concepts for novice users and continue through the introduction of advanced applications. Students will be able to enter the pathway at any point, depending on their individual experience and needs. The learning pathway will include coursework describing the development of the LANDFIRE vegetation models, as well as techniques for adapting these models to address specific land management applications.

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34   **Shi, Hua[1]**, Matthew Rollins[1], James Vogelmann[1] and Jan Verbesselt[2]

Detecting trends and seasonal changes in non-forest live fuel using remotely sensed time-series data in the Western United States

Abstract: A challenge for mapping live fuels in rangeland ecosystems is separating fuel conditions and changes from background variation. Rangelands are characterized by much seasonal and inter-annual spectral variation associated with phenology and other factors. Remote sensing systems for assessing these ecosystems, such as the Moderate Resolution Imaging Spectroradiometer (MODIS), enable characterization of intra- and inter-annual spectral conditions across all seasons. Fuel conditions in rangelands are influenced by major disturbances (fires), and phenological changes are strongly influenced by weather and climate. Breaks For Additive Seasonal and Trend (BFAST) is used for analyzing remotely sensed time series data to detect and characterize landscape trends and seasonal changes. BFAST integrates the decomposition of time series into trend, seasonal, and remainder components, which enables the detection of change within the time series. BFAST iteratively estimates the time and number of changes, and characterizes change by its magnitude and direction. A major goal of the investigation is to determine whether BFAST could be used to sufficiently detect non-forest live fuel changes for fire applications with remotely sensed time series data. BFAST was applied to smoothed 7-day normalized difference vegetation index (NDVI) USGS-EOS MODIS (eMODIS) composites from 2000–2010 for a non-forest live fuel study area in southern Nevada at pixel and landscape levels. The results showed that BFAST facilitates detection and characterization of spatial and temporal changes in a rangeland landscape, and meets LANDFIRE's needs for live fuel mapping in rangeland. Additionally, we analyzed and summarized the correlations among fire occurrence (frequency), burn severity, and live fuel types. Our results demonstrate that BFAST, applied to remotely sensed time series data, can capture spatiotemporal heterogeneity in non-forest live fuel type relevant to fire disturbances and climate/weather variation. Therefore, BFAST applied to remotely sensed time series data such as eMODIS products provides a useful and powerful mapping tool that can improve and augment existing LANDFIRE fuels data. BFAST can be used to monitor changing fuel conditions and meet the needs in response to management activities and climate change.

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14   **Shive, Kristen L.[1]**, Peter Z. Fule[1], and Carolyn Hull-Seig[2]

Influences of pre-fire treatment and fire severity on pine regeneration after a large

wildfire

Abstract: The ponderosa pine forests of the southwest are increasingly burning under uncharacteristically high severity fire. To mitigate the risk of catastrophic losses of forested landscapes, managers are increasingly applying pre-fire treatments to restore stand structure, yet the interactions between pre-fire stand structure and treatment, fire severity and post-fire pine regeneration are not well understood. We investigated these interactions on the 2002 Rodeo-Chediski fire of northeastern Arizona. This fire burned through areas that had been managed for an uneven-aged structure, where thinning and burning treatments were conducted at large landscape scales. We re-measured existing plots that were stratified by severity (low and high) and pre-fire treatment (burned, burned and thinned, untreated). We hypothesized that in areas of high severity, severity would override effects of pre-fire treatment on pine regeneration. Surprisingly we found a higher percentage of sites recording pine regeneration in pre-fire thinned and burned areas (100%) over pre-fire burned only (83%) and pre-fire untreated areas (50%). We then assessed several variables to help explain this difference in frequency. First, we found higher shrub cover in untreated areas which may be related to the amount of growing space available for pine regeneration. Second, we examined the severity matrix surrounding the study sites, and found that the thinned and burned high severity areas were couched within a more heterogeneous, mixed severity landscape, which likely provided more persistent live trees as seed sources.

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5   **Smith, Helen[*],** and Bob Keane[*]

Evaluating landscape changes in vegetation, surface, and canopy fuel properties on a small subalpine landscape in central Montana, USA after a mountain pine beetle outbreak – The TCEFGRID study

Abstract: This study in progress is measuring the spatial changes in fuel loadings across a small landscape in central Montana at the Tenderfoot Creek Experimental Forest (TCEF). This landscape is currently experiencing a mountain pine beetle outbreak that could dramatically change fuel characteristics over the next five years. We measure attributes used to calculate surface and canopy fuel loadings, and record vascular plants by species, cover, and height across a large sampling grid and repeat these measurements every ten years. We will then describe the temporal and spatial variability of these loadings, species cover, and height to relate these characteristics to biophysical attributes, such as tree density, species composition, and stand structure. We measure loadings for eight surface fuel components: four downed dead woody fuel size classes (1, 10, 100, 1000 hr), duff, litter, shrub, and herb components. We sample these fuels using planar intercept and quadrat methods. The sampling grid was initially established in 1996 where plots were spaced at 330 m intervals on a grid oriented due north and south. We describe the temporal changes in fuels, plants, tree health, and bark beetle activity and then document the spatial distribution of fuel changes along with their variance using a number of spatial statistical techniques such as spatial autocorrelation, connectivity, Moran's I, and variography. The data collected will be used to describe fuels for sampling and fire behavior and effects prediction in the Northern Rocky Mountains. This study will utilize these data to develop the next generation of fuel models that are used as input to fire effects and behavior models to more accurately simulate fires across a spatial domain. Additionally,

these data will be used to assess the impact of mountain pine beetle-caused mortality on simulated wildfire behavior and severity. Results from this study will be published in a USDA Forest Service General Technical Report and journal articles.

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17   **Strand, Eva***, Chad Hoffman*, and Steve Bunting*

Effects of fuel load, heterogeneity, and environmental conditions on fire behavior in grasslands- Results from a physics based process model

Abstract: The role of livestock grazing on fuel loads and fire behavior is important to land managers, land owners, and the general public across rangelands. Livestock grazing affects the amount and spatial distribution of herbaceous biomass, e.g. fine fuels, affecting the potential for fire spread, intensity, and fuel consumption. In addition, environmental variables such as fuel moisture, topography, and wind influences fire behavior. To better understand these complex interactions we conducted a modeling experiment using the physics based model Wildland Urban Interface Fire Dynamics Simulator (WFDS). WFDS is a coupled fire-atmosphere model governed by fluid dynamics relationships, combustion, and the thermal degradation of solid fuel. The model is applicable to heterogeneous fuel beds and has been validated with field experiments in grasslands. In this model experiment we reduced herbaceous fuels by 10%, 25%, and 50%, wind speed was held at 7.2, 18.0, and 36.0 km/h, and fuel moisture was simulated at 6%, 10%, and 17%. Fuel reduction was applied at two levels; even biomass removal and patchy biomass removal, simulating movement of animals across the range. Under these conditions the fire rate of spread varied between 1.8 and 7.2 km/h, increasing with higher winds and lower fuel moistures as expected. The fire did not spread in simulations with 17% fuel moisture or in simulations with 50% biomass removal, except at 6% fuel moisture and 36.0 km/h wind. The fire was less likely to spread when the biomass removal was patchy compared to homogeneously applied across the grassland.

*University of Idaho, Moscow

24   **Whisenant, Penny***, Brittany Compton*, Christopher Bartley* and Brian Oswald*

Piney Woods Country Club: A Firewise Community Golf Course in Texas

Abstract: The Piney Woods Country Club located in Nacogdoches, Texas is attempted to become the first Firewise Community certified Golf Course in Texas. To earn this certification fuel loads were assessed and reduced through a prescribed burning program to minimize the effects of a wildfire on the course and the facilities. In addition to prescribed burning, fire-resistant plants will be utilized to replace fire susceptible plants currently at the course. Adjacent landowners will also be asked to reduce or remove woody material or other fuels on their properties. This poster presents the fuel assessment and provide a prescription window to perform the prescribed fire to obtain the above objective.

*Stephen F. Austin State University, Nacogdoches, TX

 6   **Woolley, Travis***, Dave Shaw* and Stephen Fitzgerald*

Lodgepole pine forests following mountain pine beetle epidemics: A chronosequence of fuels and potential fire behavior for south-central Oregon

Abstract: Mountain pine beetle (*Dendroctonus ponderosae*) (MPB) has caused extensive lodgepole pine mortality in south-central Oregon, peaking at over

1,000,000 acres of mortality in 1986 and over 500,000 acres in the past decade. This widespread mortality from MPB has raised questions about the potential for catastrophic fire. A lack of data and equivocal research results about how MPB caused mortality influences temporal and spatial aspects of fuels and potential fire behavior, limits the ability of fire managers to determine when and if fuels treatments will be effective. In addition, lodgepole pine forests in south-central Oregon are ecologically unique (e.g., low cone serotiny, primarily climax lodgepole pine communities) compared to other extents of the species' range. Using a chronosequence approach, we address the following questions in south-Central Oregon to directly aid forest mangers on the Deschutes and Fremont-Winema National Forests: 1. How do fuel profiles (ground, surface, ladder and crown fuels) in lodgepole pine forests change over time in response to MPB epidemics in south-central Oregon? 2. What are the effects of MPB epidemics on future fire behavior and how does fire behavior change over time following the epidemics? Our data will be used to reconstruct ground, surface, ladder, and crown fuel succession following MPB epidemic (i.e, developing a chronosequence). To model and estimate the temporal and spatial change in potential fire behavior we will use standard fuel models or, if necessary, custom fuels models from our collected data, in conjunction with fire behavior algorithms in BehavePlus v 4.0.0, FlamMap, and FARSITE.

*Oregon State University, Corvallis

19   **Wright, Clinton***, Robert Vihnanek*, Joseph Restaino* and Jon Dvorak*

Photo Series for Quantifying Natural Fuels in Sage-Grouse and Spotted Owl Habitat in the Pacific Northwest

Abstract: Land managers must consider the Endangered Species Act and weigh the potential impacts on threatened, endangered, and sensitive wildlife species when planning and implementing resource management activities. The Natural Fuels Photo Series is a tool for conducting ecological assessments and efficiently and effectively characterizing vegetation, fuels, and habitat conditions. Habitat types important to the greater sage-grouse (*Centrocercus urophasianus*) and the northern spotted owl (*Strix occidentalis caurina*) are documented with photographs and detailed fuel and vegetation inventory data. Sagebrush-steppe sites in eastern Oregon are characterized that represent the different biophysical settings in the range of the greater sage-grouse. Mature forest types indicative of the range of nesting habitats of the northern spotted owl are characterized throughout the seven spotted owl provinces in Washington and Oregon.

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25   **Zappell, John***, Allen Rowley*, Linda Chappell*, and Robert Campbell*

Managing Wildland Fires and Public Acceptance of Longer Duration Fires in South-central Utah

Abstract: This poster uses a decision matrix to demonstrate how management decisions can be made during wildfire incidents. Fire history studies and tree cookies are used to explain the role of fire during past centuries. Opportunities to minimize risk to people and property and enhance the ecosystem benefits of fire will be explored. The poster features ways to improve public acceptance of longer duration fires.

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