

# Restoring the West 2013

## Change Agents and Managing for Forest Resilience



**October 16 & 17, 2013**  
**Utah State University**  
**Logan, Utah**  
**[www.restoringthewest.org](http://www.restoringthewest.org)**



## 2013 Restoring the West Conference Planning Committee Roster

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# Agenda

Wednesday, October 16, 2013  
USU Eccles Conference Center

7:30 to 9:00 a.m.	Registration Open
8:20 to 8:30 a.m.	<b>Welcome</b> , Chris Luecke, Dean, Quinney College of Natural Resources, Utah State University, Logan, Utah
8:30 to 8:40 a.m.	<b>Conference Overview</b> , Darren McAvoy, Forestry Extension Associate, Utah State University, Logan, Utah
8:40 to 9:20 a.m.	<b>Facilitating the interaction of science and policy to manage forests for resilience</b> , Linda A. Joyce, Quantitative Ecologist, Human Dimensions Program, USDA Forest Service Rocky Mountain Research Station, Fort Collins, Colorado
9:20 to 10:00 a.m.	<b>The consequences of changing disturbance regimes for quaking aspen in the western U.S.</b> , Dominik Kulakowski, Associate Professor, Clark University, Worcester, Massachusetts
10:00 to 10:30 a.m.	<b>Break</b>
10:30 to 11:00 a.m.	<b>The role of plant species selection in the rebuilding of resilient forest ecosystems after severe disturbance</b> , Simon M. Landhäusser, Professor and Industry Research Chair in Forest Land Reclamation, University of Alberta, Edmonton, Alberta
11:00 to 11:30 a.m.	<b>Climate change and avoiding a climate of fear</b> , Jessica Clement, Research Scientist and Program Director, Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, Laramie, Wyoming
11:30 a.m. to 12:00 p.m.	<b>Long-term vegetation and disturbance trends in the subalpine ecosystems of the Colorado Plateau</b> , Jesse L. Morris, Postdoctoral Fellow, University of Idaho, Moscow, Idaho, and Kansas State University, Manhattan, Kansas
12:00 to 1:30 p.m.	<b>Poster Session and Lunch</b>

**Wednesday, October 16, 2013**  
**USU Eccles Conference Center**

1:30 to 2:00 p.m.	<b>Forecasting climate-induced distribution shifts for the piñon-juniper complex of the western United States</b> , Thomas C. Edwards, Research Ecologist, U.S. Geological Survey, and Professor, Department of Wildland Resources, Utah State University, Logan, Utah
2:00 to 2:30 p.m.	<b>Whitebark pine: To manage or not to manage in the face of climate change</b> , Liz Davy, District Ranger and Certified Silviculturist, Caribou-Targhee National Forest, Ashton/Island Park Ranger District, Ashton, Idaho
2:30 to 3:00 p.m.	<b>Break</b>
3:00 to 3:30 p.m.	<b>Aspen reproduction following fire in central Arizona: Surprises and challenges</b> , Mary Lou Fairweather, Plant Pathologist, Arizona Zone Forest Health Protection, USDA Forest Service, Flagstaff, Arizona
3:30 to 4:00 p.m.	<b>Aspen fire ecology and climate change: Disturbance dynamics in an uncertain future</b> , Doug Shinneman, Research Fire Ecologist, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Boise, Idaho
4:00 to 5:00 p.m.	<b>Restoring the frequent-fire forests and landscapes: Science, pragmatism, and the critical role of collaborative groups</b> , Jerry F. Franklin, Professor, School of Environmental and Forest Science, University of Washington, Seattle, Washington
5:00 p.m.	Adjourn
6:00 p.m. to ??	<b>Reception at Cafe Sabor</b>

# Agenda

Thursday, October 17, 2013  
 USU Eccles Conference Center

8:30 to 8:40 a.m.	<b>Welcome</b>
8:40 to 9:20 a.m.	<b>Managing for resilience through a “portfolio approach” to reducing climate risk</b> , Greg Aplet, Senior Director of Ecology, The Wilderness Society, Denver, Colorado
9:20 to 9:50 a.m.	<b>From principles to practice: Restoring dry, frequent-fire forests in the face of global change along Colorado’s Front Range</b> , Rob Addington, Research Associate, Colorado Forest Restoration Institute, Colorado State University, Fort Collins, Colorado
9:50 to 10:20 a.m.	<b>Break</b>
10:20 to 10:50 a.m.	<b>Is there a case for restoration to regenerate subalpine forests following bark beetle-caused mortality?</b> , Kristen Pelz, Graduate Research Assistant and PhD Candidate, Colorado State University, Fort Collins, Colorado
10:50 to 11:20 a.m.	<b>A collaborative approach to resilience: The Monroe Mountain Working Group</b> , Steve Daniels, Professor and Extension Community Development Specialist, Utah State University, Logan, Utah
11:20 a.m. to 12:05 p.m.	<b>Up-and-coming Research Presentations</b>
11:20 a.m. to 11:35 p.m.	<b>Evaluation of treatment success in <i>Populus tremuloides</i>: Implications for management</b> , Justin Britton, M.S. Research Assistant, Department of Wildland Resources, Utah State University, Logan, Utah
11:35 a.m. to 11:50 a.m.	<b>USDA Forest Service’s perspectives on forest management in a climate change</b> , Jamie Laatsch, M.S. Research Assistant, Department of Environment and Society, Utah State University, Logan, Utah
11:50 a.m. to 12:05 p.m.	<b>Institutional resilience of the US Forest Service</b> , Emily Platt, PhD Candidate, Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, Oregon
12:05 to 1:00 p.m.	<b>Lunch</b>

**Thursday, October 17, 2013**  
**USU Eccles Conference Center**

1:00 to 1:30 p.m.	<b>Seedlings and suckers, stands and clones - so you think you know aspen?</b> , James Long, Professor, Department of Wildland Resources and Karen Mock, Associate Dean, Quinney College of Natural Resources, Utah State University, Logan, Utah
1:30 to 2:00 p.m.	<b>Mapping evidence of historical and potential wildfire for climate change and fuels mitigation in the montane forests of the Colorado Front Range</b> , Rosemary Sherriff, Associate Professor, Humboldt State University, Arcata, California
2:00 to 2:30 p.m.	<b>Beaver: Restoration liaison between riparian and upland systems</b> , Joe Wheaton, Assistant Professor and Fluvial Geomorphologist, Utah State University, Logan, Utah
2:30 to 3:00 p.m.	<b>Break</b>
3:00 to 3:30 p.m.	<b>The many faces of quaking aspen: Biogeography meets resilience management</b> , Paul Rogers, Director, Western Aspen Alliance, Logan, Utah
3:30 to 4:00 p.m.	<b>Climate change and forest disturbance: The case of the mountain pine beetle</b> , Barbara Bentz, Research Entomologist, USDA Forest Service Rocky Mountain Research Station, Logan, Utah
4:00 to 4:30 p.m.	<b>Management lessons from recent aspen declines and climate</b> , James J. Worrall, Forest Pathologist, USDA Forest Service, Gunnison, Colorado
4:30 to 4:45 p.m.	<b>Wrap up</b>
4:45 p.m.	<b>Adjourn</b>

# Speaker Abstracts

In order of presentation,  
presenting author in italics

## **Facilitating the interaction of science and policy to manage forests for resilience**

*Linda A. Joyce*, Quantitative Ecologist, Human Dimensions Program, USDA Forest Service Rocky Mountain Research Station, Fort Collins, Colorado

The science is clear; human behaviors have resulted in observable differences in the dynamics of change agents such as insects and fire, through landscape change, human settlement, and chemical changes in the atmosphere and associated climate change. We have a legacy of past management and what actions we take today could lead to a new future legacy. These landscape changes, climate change and the increasing urbanization of the West have stimulated research; scientists who study forests and rangelands are now carefully considering the behaviors of change agents, and how these change agents may affect and be affected by ecosystem dynamics under a changing climate. This scientific information has rapidly accumulated. Hence there is a need for a mutual sharing of information – from scientists, the scientific information about these change agents and, from resource managers, the experiential knowledge gained from working in these changing landscapes. This technical dialogue focuses on what resource management activities will be needed to manage for resilience. While science contributes to policy formulation, policy is influenced by many factors such as the desires of society for specific goods and services from forests. Goods and services produced in forests are likely to change in response to insects, fire, and climate change. Whether or how management can sustain current goods and services is the focus of the technical conversation. Policy development involves a broader conversation with society about what goods and services are to be sustained or newly managed for in forests. Science and management can analyze the implications of those societal choices on water availability, forest health, and risk of fire or flooding. Recent studies have stressed the need for more explicit recognition and understanding of the important role social learning plays in these discussions of societal choices, and in the implementation of management and development of policy.

Linda A. Joyce, Human Dimensions Program, USDA Forest Service Rocky Mountain Research Station, 240 West Prospect Road, Fort Collins, CO, 80526, [ljoyce@fs.fed.us](mailto:ljoyce@fs.fed.us)

*Linda Joyce is a quantitative ecologist with the Human Dimensions Research Program, at US Forest Service, Rocky Mountain Research Station and a faculty affiliate in the Forest Rangeland Stewardship Department and the Graduate Degree Program in Ecology, both at Colorado State University. For the last 20 years, her research has focused on quantifying the impacts of climate change on ecosystems, wildlife habitat, and the socio-economic implications of climate change. She works with other western scientists on developing tools for natural resource managers and planners to use in considering adaptation options for climate change. She recently completed a research project on climate change vulnerability in the Shoshone National Forest, Wyoming and is partnering with USFS Region 2 on a vulnerability assessment of 6 priority ecosystems. As the Climate Change Specialist with the Forest Service RPA Assessment, she coordinates and advises on the analysis of climate change effects on renewable natural resources at the national scale for the RPA Assessment. Currently, she is the co-Convening Lead Author for the Forest Chapter in the 2013 U.S. National Climate Assessment. She has published over 100 publications, including contributions to international and national climate change assessments. She received a PhD in Range Ecology from Colorado State University.*

## **The consequences of changing disturbance regimes for quaking aspen in the western U.S.**

Dominik Kulakowski, Associate Professor, Clark University, Worcester, Massachusetts

Forest ecosystems are being affected by both the indirect and direct results of climate change. Indirect drivers include increasing extent, magnitude and/or frequency of various forest disturbances such as wildfires and insect outbreaks. Direct drivers include droughts and altered temperature and precipitation regimes. Together these drivers are likely to affect the composition of Rocky Mountain forests, including the dominance and extent of quaking aspen (*Populus tremuloides*). Here I review recent work on these topics and propose possible future consequences for quaking aspen. Warm and dry conditions generally result in increased wildfires and bark beetle outbreaks, particularly in coniferous forests. Both of these disturbances have the potential to increase aspen dominance due to aspen's ability to regenerate in and dominate post-disturbance environments. Furthermore, compounded disturbances (i.e. two or more disturbances occurring in short succession) also appear to favor regeneration of aspen over conifers and could further increase aspen dominance if compounded disturbances increase with projected shifts in climate regimes. However, aspen demography is contingent on favorable climatic conditions. If the same warm and dry conditions that bring about disturbance regimes potentially favorable to aspen dominance also characterize post-disturbance environments, these climatic conditions may actually inhibit the ability of aspen to regenerate, grow, and survive. If aspen is able to increase dominance due to changing disturbance regimes and a changing climate, this will likely affect forest susceptibility to subsequent disturbances. As aspen stands are generally more mesic than adjacent conifer stands, the former are less likely to burn. Aspen stands are also less susceptible to bark beetle outbreaks that affect conifers and to wind disturbances. Thus any change in the amount of aspen in the landscape has the potential to feedback to the overall disturbance regime at broad scales. The consequences of changing disturbance regimes for quaking aspen in the western U.S. are likely to be complex and contingent on post-disturbance climatic conditions as well as on feedbacks among climate, disturbances, and forest species composition.

Dominik Kulakowski, School of Geography, Clark University, 950 Main Street, Worcester, MA, 01610, [dkulakowski@clarku.edu](mailto:dkulakowski@clarku.edu)

*Dominik Kulakowski is an Associate Professor of Geography and Biology at Clark University, where he also directs the Forest Ecology Research Lab. He received a Bachelor of Science degree in Environmental Resource Management and a Master of Science degree in Ecology from Penn State University and a Ph.D. in Geography from University of Colorado. His research is focused on the disturbance ecology of mountain forest ecosystems in the U.S. Rocky Mountains and the European Alps. Specific research themes include how disturbances interact under varying climatic conditions to determine regeneration and mortality in forest ecosystems.*

## **The role of plant species selection in the rebuilding of resilient forest ecosystems after severe disturbance**

Simon M. Landhäusser, Professor and Industry Research Chair in Forest Land Reclamation, University of Alberta, Edmonton, Alberta

Resource extraction results in severe disturbance to landscapes representing a range of boreal forest ecosystems. In Canada, operators are obligated to “revegetate the disturbed land to... self-sustaining, locally common boreal forest ...” An understanding of the natural processes, relationships, and dynamics in these forest ecosystems is key to rebuilding resilient and sustainable boreal forests. In this context, resilience can encompass both recovering from the mining disturbance and the capacity to recover from future natural disturbances and

stresses. In this presentation, I will discuss the aspect of selection and establishment of plant species in restoring diverse and productive forest ecosystems, which therefore possess properties that are likely to confer resilience. Recognizing the role of the species being reintroduced during the recovery of severely disturbed areas is critical in determining the trajectories along which reclaimed forest stands develop. As such, the autecology and life-history traits of these species and their abundance through time and space are critical to assess resistance and resiliency of these future ecosystems. In this presentation, I will give examples of some of the roles plants and their traits play in the development of resistance and resiliency in reclaimed novel ecosystems emphasizing linkages among plants and ecosystem processes.

Simon M. Landhäusser, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, T6G 2E3, Canada, Simon.Landhausser@ualberta.ca

*Simon M. Landhäusser is a Professor in Forest Ecology and Silviculture at the University of Alberta, Edmonton, Alberta, Canada. He also holds a NSERC Industry Research Chair in Forest Land Reclamation. He received his B.Sc. and M.Sc. (Diplom) in Ecology at the University of Tübingen, Germany and a Ph.D. in Forestry at the University of Alberta. He has been involved in over 25 years of research and consulting in boreal and temperate forest ecosystems. His current research addresses questions related to the reclamation of disturbed lands to self-sustaining forest ecosystems common to the boreal forest region. The research program focuses on the function and underlying processes of forest canopy cover as a prime factor in determining forest successional pathways. Key research activities are the development of innovative strategies and techniques for the re-establishment of forests on surface mined lands and determining whether these forests develop and display processes and functions comparable to natural ecosystems. Other active research and research interests are: ecophysiology (growth, photosynthesis, water relations, and carbon allocation) of boreal forest species in response to different abiotic and biotic factors, the effects of forest practices on aspen regeneration and boreal forest vegetation management, and the role of disturbance on forest establishment and tree species distribution.*

### **Climate change and avoiding a climate of fear**

Jessica Clement, Research Scientist and Program Director, Ruckelshaus Institute for Environment and Natural Resources, University of Wyoming, Laramie, Wyoming

Discussing climate change and its implications is not easy. On the one hand, there is the need to understand this phenomenon and the current and future effects of it; on the other hand, these concepts are so huge, they are difficult for the human brain to absorb and psychologically process. In the discourse regarding climate change communications, many have noted reactions that range from anger, denial, fear to panic. In this presentation, Jessica will summarize her findings regarding climate change communications from various sources. She will offer some suggestions regarding what science communication techniques and methods specifically related to climate change may be more effective in light of the capacity and limitations of the human brain.

Jessica Clement, Ruckelshaus Institute, Environment and Natural Resources, University of Wyoming, 804 Fremont Street, Laramie, WY, 82072, jessica.clement@uwyo.edu

*Jessica Clement is Director of the Collaborative Program in Natural Resources and Research Scientist in Human Dimensions in Natural Resources at the Ruckelshaus Institute of University of Wyoming. She is a scientist, practitioner and teaches in the fields of human dimensions and policy in natural resources at the Ruckelshaus Institute. The Ruckelshaus Institute seeks to enhance collaborative capacity in environmental and natural resource issues in Wyoming and beyond. She has created the Collaboration Program, which trains*

*middle and upper management natural resource professionals in collaborative problem-solving methods. Dr. Clement was previously the Co-Director of the Colorado Forest Restoration Institute at Colorado State University. She has created and facilitated collaborative processes related to natural resource issues for more than 15 years in Colorado, Wyoming, and Montana. Jessica has also published peer-reviewed articles in human dimensions research regarding the relationship between people and natural resources using quantitative, qualitative and GIS methods and taught natural resources policy and ecology related subjects for twenty years.*

**About the Ruckelshaus Institute at the University of Wyoming:** *The Ruckelshaus Institute at the University of Wyoming advances the understanding and resolution of complex environmental and natural resources challenges and supports stakeholder-driven solutions to environmental challenges by communicating relevant research and promoting collaborative decision making through research and policy analysis, collaborative problem solving, events and trainings and publications.*

### **Long-term vegetation and disturbance trends in the subalpine ecosystems of the Colorado Plateau**

Jesse L. Morris, Postdoctoral Fellow at the (1) University of Idaho, Moscow, Idaho and (2) Kansas State University, Manhattan, Kansas

During the mid-1800s, the livelihoods of European settlers arriving to the Colorado Plateau relied heavily upon timber and forage resources located in the subalpine highlands. Over the 20th century, these ecosystems remained vitally important to conservation and society, as melting snowpack sustains many iconic, desert-themed National Parks and also provides recharge to the Colorado River. Additionally, the forested uplands are regional economic centers for ski and summer tourism and also provide forage for sheep and cattle. In recent decades, many of these landforms were impacted by severe native bark beetle outbreaks and wildfire. In the popular media, these disturbances are frequently portrayed as artifacts of climate warming. Yet long-term ecological data suggests that the mechanisms promoting these disturbances are more complex and that the ecological status of these systems are deeply intertwined with historical land-use practices – not simply climate alone. A key challenge facing stewards and stakeholders in the Colorado Plateau region is developing a synthesis of short and long-term ecological data that is useful for management. This talk will focus on utilizing centennial- to millennial-scale records of vegetation and disturbance to contextualize 21st century climate change and associated shifts in disturbance regimes.

Jesse L. Morris, (1) University of Idaho Department of Forest, Rangeland and Fire Sciences, 875 Perimeter Drive, MS1133, Moscow, ID, 83844; (2) Kansas State University Department of Geography, 118 Seaton Hall, Manhattan, KS, 66506, [jlmorris@uidaho.edu](mailto:jlmorris@uidaho.edu)

*Jesse L. Morris is currently a postdoctoral fellow at the University of Idaho and Kansas State University. He received his B.A. degree in Geography from the University of South Carolina in Columbia and his M.S. and Ph.D. degrees from the University of Utah in Salt Lake City. Dr. Morris is broadly interested in how forest ecosystems respond to climate and disturbance, particularly native insects, logging, and wildfire. His recent research activities include investigations focusing on long-term, climate-mediated changes to latitudinal treeline in Arctic Russia and also how anthropogenic burning interacts with endemic conifer recruitment in Tasmania. In western North America, he continues to work towards understanding how both climatic and human perturbations to coniferous forests alter pre- and post-disturbance ecosystem structure and composition.*

## **Forecasting climate-induced distribution shifts for the piñon-juniper complex of the western United States**

Thomas C. Edwards, Research Ecologist, U.S. Geological Survey, and Professor, Utah State University, Logan, Utah

Piñon and juniper vegetation types cover >30% of the Colorado Plateau. Two species and one variety of piñon pine (*Pinus monophylla*, *P. edulis*, *P. monophylla* var. *fallax*), and four species of juniper (*Juniperus osteosperma*, *J. monosperma*, *J. deppeana*, *J. arizonica*) are dominant in the region. They comprise a mosaic of overlapping distributions arranged primarily across a gradient of seasonal precipitation. Individual species have been found to respond uniquely to climate changes, causing shifts in the co-occurrence of species. This is reflected in the differential mortality among species caused by recent droughts, which appears to indicate long-term distribution shifts have already begun. We developed bioclimatic distribution models and applied climate change scenarios to gauge potential shifts in the distributions of individual species and their co-occurrence. The application of climate change scenarios resulted in, for each species / variety, the spatial depiction of currently inhabited areas no longer suitable for regeneration as well as currently uninhabited areas becoming suitable for colonization. Our results suggest individualistic responses of species to climate change will likely cause shifts in their spatial co-occurrence. For example, *J. osteosperma* is predicted move northwest whereas *J. monosperma* is predicted to move northeast resulting in a decrease of co-occurrence. *P. edulis* is predicted to increasingly co-occur with *J. osteosperma* while *P. monophylla* is predicted to decrease or increase depending on the climate change scenario. The character of individual species distributions shifts and their resulting changes in co-occurrence will be largely determined by changes in the summer monsoon rains and in the minimum winter temperatures.

Thomas C. Edwards, U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit, and Utah State University Department of Wildland Resources, 5230 Old Main Hill, Logan, UT, 84322-5390, t.edwards@usu.edu

*Dr. Edwards received his B.S. in Wildlife Management from Humboldt State University in 1980, his M.S. in Ecology from the University of New Mexico in 1983, and his Ph.D. in Wildlife Ecology from the University of Florida in 1987. He currently is a Research Scientist with the US Geological Survey Utah Cooperative Fish and Wildlife Research Unit and Professor in the Department of Wildland Resources and Ecology Center, Utah State University. Dr. Edwards teaches graduate level classes in The Design and Analysis of Ecological Research, as well as numerous R-based “espresso” shortcourses in analytical techniques for ecologists, species distribution modelling, and bioclimatic forecast modelling.*

Co-authors: Jacob R. Gibson, Utah State University, Logan, Utah; Gretchen G. Moisen, and Tracey S. Frescino, USDA Forest Service Rocky Mountain Research Station, Ogden, Utah; and Niklaus Zimmermann, Swiss Federal Research Institute, Birmensdorf, Switzerland

### **Whitebark pine: To manage or not to manage in the face of climate change**

Liz Davy, District Ranger and Certified Silviculturist, Caribou-Targhee National Forest, Ashton/Island Park Ranger District, Ashton, Idaho

There is a great deal of controversy in the management world on the fate of whitebark pine under future climate change. Many feel that projected warmer conditions will reduce whitebark pine habitat. For this reason, some land managers and agency leadership question the validity of whitebark pine restoration activities and

funding. Others feel that climate-mediated changes in the disturbance regimes will serve to keep whitebark pine within its current range, albeit at lower levels (Loehman et al. 2011). It is all much more complex due to the high uncertainty in climate change predictions, species responses, and disturbance interactions. Therefore, we suggest that the question of whether to restore ecosystems is not dependent on future climates since we really can't predict them and how landscapes will respond to them, but rather, it is dependent on whether society can afford the loss of this foundation and keystone ecosystem. Climate, like insects, disease, and land management, is a factor that must be mitigated in restoration attempts and not a reason for curtailing restoration actions.

Liz Davy, USDA Forest Service, Caribou-Targhee National Forest, Ashton/Island Park Ranger District, P.O. Box 858, Ashton, ID, 83420, edavy@fs.fed.us

*Liz Davy is a District Ranger on Ashton/Island Park Ranger District in Southeastern Idaho. Prior to becoming a line officer, she worked in timber, reforestation and silviculture for the Forest Service. She has spent most of her career in the Greater Yellowstone Ecosystem as a Silviculturist. Liz served on the Greater Yellowstone Ecosystem whitebark pine subcommittee and was instrumental in the creation of the whitebark pine strategy for that area. Liz was the Forest Silviculturist on the Bridger-Teton during the recent mountain pine beetle epidemic and experienced the total devastation of thousands of acres of whitebark pine. She has spent her entire career in forest management. Liz is passionate about whitebark pine, its restoration and management. She serves on the Board of Directors for the Whitebark Pine Ecosystem Foundation and is on the steering committee for the Western Aspen Alliance. She is also an avid bike rider completing her first Century road ride this year and the Canadian section of the Great Divide Mountain bike trail last year. Liz's home is Driggs, Idaho when she is not working and partakes in the fantastic cross country skiing opportunities that area has to offer.*

### **Aspen reproduction following fire in central Arizona: Surprises and challenges**

Mary Lou Fairweather, Plant Pathologist, Arizona Zone Forest Health Protection, USDA Forest Service, Flagstaff, Arizona

Due to widespread increase in wildfire, previously established permanent plots allow unexpected post-fire observations. Aspen within the surveyed area of the 2010 Schultz Fire sprouted abundantly following fire. Regeneration density averaged >24,700 stems/hectare in 2012. Aspen density varied widely across the area due in part to ungulate browse impacts, but was also likely influenced by pre-fire aspen and conifer densities. Aspen stem density and heights increased for the first time since the plots were established in 2003. Although aspen along the Waterline Road are abundant and growing taller than they were in 2003, the majority of plots suffered heavy ungulate browse, exceeding 65% of stems browsed. An abundant crop of aspen seedlings occurred in 2011. Although we observed survival of seedlings in 2012, they became difficult to distinguish from sprouts without excavation. Although this study is based on a limited, serendipitous plot network, the implications of seedling production and survival are important, especially in light of climate change.

Mary Lou Fairweather, Arizona Forest Health Protection, Southwestern Region, USFS, 2500 S. Pine Knoll Drive, Flagstaff, AZ, 86001, mfairweather@fs.fed.us

*Mary Lou Fairweather provides technical assistance on tree diseases to federal and tribal land managers throughout the state of Arizona. Her current focus includes exploring the factors involved in the dieback and decline of aspen forests. Her focus includes the agents involved in aspen dieback and decline, particularly ungulate browse impacts on aspen regeneration; dwarf mistletoe and root disease ecology and management; monitoring southwestern white pine stands for white pine blister rust; and training hazard tree identification*

*and mitigation. She received a B.S. in Biology, from Fort Lewis College in Durango, Colorado, and an M.S. in Plant Pathology, from the University of Arizona in Tucson, Arizona.*

### **Aspen fire ecology and climate change: Disturbance dynamics in an uncertain future**

Doug Shinneman, Research Fire Ecologist, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Boise, Idaho

Aspen is the only deciduous tree species with substantial extent across much of the western United States, and decline of aspen woodlands due to climate change would likely alter ecological processes and result in cascading losses of animal and plant species in the region. Recent aspen mortality events in the western U.S. might be harbingers of future aspen disturbance dynamics under climate change, and some climate-based vegetation models suggest substantial loss of aspen over the next several decades. However, the role of future disturbance, particularly fire, complicates our ability to predict aspen distribution and productivity under climate change. Aspen is typically seral to conifer tree species, re-sprouts prolifically after fire and, thus, is often considered to be a fire-dependent species. However, some aspen populations may be stable in the absence of fire, and a recent review suggests at least five aspen fire regime types are possible. Thus, although hotter and drought-prone future climates may increase aspen mortality in some locations (e.g., at lower elevations), these same climate conditions are also predicted to increase wildfire activity across much of the western United States, and this could be beneficial to aspen in other locations (e.g., at higher elevations where conifers now dominate). Here, I present an overview of aspen-fire dynamics in the western U.S., including describing different aspen fire regimes, and discussing how future climate-fire interactions might affect aspen populations. I also present preliminary modeling results as a case study for potential changes in aspen distribution and abundance under alternative future climate scenarios and fire regimes in the northern Great Basin. I then discuss the relevance of this research to aspen restoration efforts, highlight key areas of scientific uncertainty, and suggest high-priority research areas.

Doug Shinneman, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, 970 Lusk Street, Boise, ID, 83706, dshinneman@usgs.gov

*Douglas Shinneman is a Research Fire Ecologist with the USGS Forest and Rangeland Ecosystem Science Center, in Boise, Idaho. He received a B.S. from Michigan State University, and an M.A. in Geography and Ph.D. in Botany (2006) from the University of Wyoming. His research investigates the ecological role of fire in shrubland and forest ecosystems, and how plant communities and disturbance regimes are influenced by land use, nonnative species, and climate.*

### **Restoring the frequent-fire forests and landscapes: Science, pragmatism, and the critical role of collaborative groups**

Jerry F. Franklin, Professor, School of Environmental and Forest Science, University of Washington, Seattle, Washington

A broad scientific consensus now exists regarding the urgent need for massive efforts to restore resiliency to western forests and landscapes that were historically characterized by the occurrence of frequent, low to mixed-severity wildfire. Important elements of this consensus include the need to focus on restoring ecosystem processes rather than on fuels and strategic fuel breaks, planning and implementing activities at larger spatial scales, incorporating more natural and prescribed fire into plans, and prioritizing areas where greater natural resource values are at risk. Although restoration treatments need to focus on desired future conditions, rather

than past conditions, recent historic research is making it increasingly clear that conditions in most western pine and mixed-conifer forests are far outside of their historic range of variability and that natural resource values (such as old tree populations) are often most at risk in mixed-conifer forests. Collaborative groups are proving critical in moving restoration programs forward, engaging and often empowering agency personnel in these activities. These collaborative groups need to be embraced by agencies and participate in all aspects of the restoration programs on public lands including critical elements of adaptive management – design and implementation of monitoring programs and interpretation of monitoring data, including appropriate adaptive changes to management and monitoring programs. In the 20th century, collaborative groups may represent the most important interface between the American public and federal land management agencies.

Jerry F. Franklin, School of Environmental and Forest Science, University of Washington, Box 352100, Seattle, WA, 98195, [jff@u.washington.edu](mailto:jff@u.washington.edu)

*Jerry Franklin received BS (1959) and MS (1961) degrees in Forest Management from Oregon State University and a PhD in Botany and Soils (1966) from Washington State University. He worked in USDA Forest Service Pacific Northwest Station for nearly 35 years as research scientist, project leader, and Chief Plant Ecologist before moving to the University of Washington as a Professor of Ecosystem Science in 1986, where he continues to be employed. He was also Program Director for Ecosystem Studies at the National Science Foundation (1973-1975) and Chairman of the Long Term Ecological Research Coordinating Committee and Director from 1982 to 1996, among other activities. His research has focused largely on structure and function of forest ecosystems, ecosystem responses to natural disturbances (e.g., at Mount St. Helens), ecology and restoration of frequent-fire forest ecosystems, and applications of ecological knowledge in policy and management of federal forests.*

### **Managing for resilience through a “portfolio approach” to reducing climate risk**

Greg Aplet, Senior Director of Ecology, The Wilderness Society, Denver, Colorado

Climate change promises to erode ecosystems and undermine more than a century of conservation gains. Protected area managers can no longer expect protection or restoration alone to sustain ecological integrity and instead must identify strategies to increase the resilience of ecosystem elements as ecosystems change. To “buy time” for diverse, future ecosystems to develop, conservation priorities should focus on maintaining those elements that take a long time to develop, including soils and the genetic diversity in populations. Unfortunately, uncertainty about the future of ecosystems under climate change dictates that it is unknowable which strategy will work “best,” and a “portfolio” of approaches must be tried to spread the risk of loss. We argue that protected area adaptation is best served by allocating wildlands to three zones: 1) a Restoration Zone where whole ecosystems are actively maintained and change is resisted, 2) an Observation Zone where directional change is accepted, and 3) an Innovation Zone where change is guided into conditions unlike the past but with a better chance of sustaining highly valued ecosystem elements and processes in the long term. Such a spatially explicit approach can provide a framework for evaluating the appropriateness of various “adaptation options” and facilitate adaptive management to minimize climate risk. The presentation will close with consideration of criteria to guide allocation of the landscape to the portfolio.

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### **From principles to practice: Restoring dry, frequent-fire forests in the face of global change along Colorado's Front Range**

Rob Addington, Research Associate, Colorado Forest Restoration Institute, Colorado State University, Fort Collins, Colorado

In the last decade, much emphasis has been placed on restoration of dry coniferous forests of the western U.S. out of concern that these forest types are increasingly vulnerable at large scales to severe disturbance and impacts related to global change. Along Colorado's Front Range, some 1.5 million acres of ponderosa pine and dry mixed-conifer forests have been identified as in need of treatment to improve forest health and to protect communities. While consensus has been reached regarding general restoration goals, the process and path forward for achieving desired outcomes has not been clearly articulated. I will describe a science-based restoration framework being developed for Front Range forests that emulates natural disturbance patterns, forest developmental processes, and variation across environmental gradients in order to enhance forest complexity and heterogeneity at multiple scales. Key components of the approach include multi-scaled planning to identify priority areas for treatment, and treatment designs that reduce densities, enhance spatial heterogeneity, retain drought- and fire-tolerant species, and retain old trees. Implementation of the framework is expected to enhance forest resilience and help reestablish a low to mixed-severity fire regime through either prescribed fire or management of wildland fire. Additionally, the framework emphasizes the importance of adaptive management and opportunity for learning through monitoring and experimentation in order to address uncertainty that accompanies the restoration process.

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*Rob Addington is a Research Associate with the Colorado Forest Restoration Institute (CFRI) at Colorado State University, where he specializes in the application of science to restoration management. Rob received B.S. degrees in Biology and English from the University of Colorado at Boulder and holds a Master's degree in Plant Biology from the University of Georgia. Prior to his position with CFRI, Rob worked for The Nature Conservancy in Georgia for nearly 10 years, specializing in longleaf pine ecosystem restoration and ecological monitoring of prescribed fire and other restoration activities. Rob is currently working with a multiparty collaborative to develop science-based guidance for restoration of ponderosa pine and dry mixed-conifer forests along the Colorado Front Range.*

### **Is there a case for restoration to regenerate subalpine forests following bark beetle-caused mortality?**

Kristen Pelz, Graduate Research Assistant and PhD Candidate, Warner College of Natural Resources, Colorado State University, Fort Collins, Colorado

Recent bark beetle outbreaks have prompted calls for increased management of subalpine forest in the southern Rocky Mountains. However, bark beetles play an important role in forest regeneration dynamics of these systems. Subalpine forests affected by mountain pine beetle are dominated by lodgepole pine, but often have components of quaking aspen, subalpine fir and Engelmann spruce. Beetle outbreaks shift the relative recruitment success and growth of these four species, affecting forest composition and structure for decades. This, in turn, will affect socially and ecologically important processes, such as those related to fire behavior, wildlife use, and water yield, for decades to come. Based on current conditions in beetle affected forests, to what extent can we predict future species composition? Where may we expect recruits of aspen, Engelmann spruce, lodgepole pine, or subalpine fir to thrive post-beetle? And, what might desirable future compositions be in these forests and is management necessary to encourage them?

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### **A collaborative approach to resilience: The Monroe Mountain Working Group**

Steve Daniels, Professor and Extension Community Development Specialist, Utah State University, Logan, Utah

The Monroe Mountain Working Group (MMWG) is a voluntary assembly of people addressing aspen viability at a landscape scale on Monroe Mountain of central Utah. A wide range of organizations and perspectives have been involved either as voting members or guests: environmental groups, grazing permittees, state agencies, county government, private landowners, and the USDA Forest Service, which has the dominant decision authority on the landscape. The process has many similarities to other working groups that are dealing with local-scale natural resource management issues throughout the West, ranging from species conservation to wildfire risk mitigation. This presentation provides a brief overview of the process and structure of the MMWG in order to set the context for exploring the accomplishments and challenges the project has experienced.

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*Steve Daniels has been in his current position since 2004; he had previously been the Director of the Western Rural Development Center at Utah State University (1999-2004), on the faculty at Oregon State University as a professor of forest policy and economics (1989-1999) and on the faculty of Utah State University (1986-1988). Much of Dr. Daniels' professional interest focuses on community linkages to natural resources and in collaborative processes in natural resource management. He has been involved in a number of community-level collaborations, primarily in the Pacific Northwest. With Dr. Gregg Walker of OSU, he is a co-author of Working Through Environmental Conflict: The Collaborative Learning Approach. In addition to the Collaborative Learning book, Dr. Daniels has published more than 80 scientific papers, book chapters, and reports. Many of these report experiences or methods developed through Collaborative Learning projects on behalf of agencies or*

*communities. Working with various federal natural resource management agencies has been Dr. Daniels' major area of practice. As a result of this broad base of experience, Dr. Daniels has taught in courses for several agencies, NGOs, and at 21 universities in the USA and abroad.*

### **Evaluation of treatment success in *Populus tremuloides*: Implications for management**

Justin Britton, M.S. Research Assistant and NIFA Fellow, Department of Wildland Resources, Utah State University, Logan, Utah

Aspen management in the Intermountain West has conventionally relied on its ability to vegetatively reproduce, and has long been used to guide silviculture (e.g., coppice systems). Aspen is prolific in its sprouting response to overstory removal, capable of producing thousands of shoots per hectare. The successful reproduction of aspen is of considerable management interest. Without intervention, current threats to the persistence of aspen communities may lead to the continued decline of aspen in the Intermountain West. Successful regeneration is defined as the timely recruitment of a new cohort of aspen stems such that they are no longer susceptible to herbivory or other detrimental factors associated with juvenility. In the broader context of aspen ecology, we can postulate three important drivers of successful aspen regeneration: (1) stand vigor, (2) disturbance history (e.g., management actions), and (3) climatic conditions. A multitude of interactions between these drivers likely ultimately determines the timing, quantity, and quality of aspen regeneration. We measured sites with known management histories on Cedar Mountain and southwestern Utah in order to quantify the success of regeneration based on a comparison of unique pre-treatment versus post-treatment stand conditions. By simultaneously exploring a multitude of factors that possibly affect aspen regeneration, this research: (1) sampled across multiple stand conditions (N=103), elucidating a diversity of regeneration drivers; (2) identified multiple management scenarios for successful aspen regeneration; and (3) incorporated state-of-the-art knowledge regarding aspen regeneration ecology into a management guide.

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### **USDA Forest Service's perspectives on forest management in a changing climate**

Jamie Laatsch, M.S. Research Assistant, Department of Environment and Society, Utah State University, Logan, Utah, and Zhao Ma, Assistant Professor, Department of Forestry and Natural Resources, Purdue University, West Lafayette, Indiana, and Adjunct Assistant Professor, Department of Environment and Society, Utah State University, Logan, Utah

The USDA Forest Service is facing unprecedented challenges due to climate change. Understanding the perspectives of forest managers and policy makers will provide invaluable insight into these challenges and help identify opportunities for strengthening the agency's ability to adapt to climate change and enhance forest resilience. By analyzing data from key informant interviews and an internet survey in the Intermountain West,

this study examines perspectives within the Forest Service with respect to what challenges forest managers face in today's changing climate, how forest management is currently conducted in the face of climate change, what resources or support may be needed to help forest managers better address climate change when managing the National Forests, and how these perspectives vary at different levels of agency management, from district operations to national policy making. Although most respondents recognize the need for climate change mitigation and adaptation, their ability to implement relevant plans has been limited due to a lack of site-specific data and information, the need for more practical, applicable direction from the agency, insufficient resources for on-the-ground actions, and competing priorities and responsibilities. However, this does not mean that forest managers have not tried to indirectly address issues related to climate change. Efforts have been made to develop projects and strategies that can be incorporated into existing management plans, like increasing species diversity and complexity or promoting species that are expected to be better suited to future climate conditions in a given area. To move forward, better communication between forest scientists, managers, and policy makers is needed with respect to potential management options and the various effects of climate change on the forest ecosystem at relevant scales. Innovative policy frameworks are also needed to support and guide forest managers and to give them the “degrees of freedom” they need to make a real, positive impact.

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### **Institutional resilience of the US Forest Service**

Emily Platt, PhD Candidate, Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, Oregon

This research is part of the Forests People Fire (FPF) coupled natural-human systems project. FPF is building an agent-based model to explore how social and ecological systems interact to shape fire-prone landscapes over time. The FPF project area includes forested areas in central and south-central Oregon. Roughly 50% of the area is managed by the Forest Service. The Forest Service is working to restore fire-prone forests within the project area. A range of issues from local social dynamics to congressional politics influence the Forest Service's ability to address restoration needs and challenges, and these influences are constantly shifting and changing. The study area's fire prone landscape adds an element of rapid ecological change. This research considers the Forest Service's ability to adapt to these constantly changing conditions. The Forest Service's institutional resilience is assessed by considering both its ability to adapt to changing social and ecological conditions as well as its ability to meet goals and objectives outlined in the Forest Service's strategic plan, the national fire plan, the 2012 planning rule, and management plans for the Deschutes and Fremont-Winema National Forests. Qualitative analysis of interview data is paired with ecological modeling to explore obstacles to restoration of federal lands and landscape outcomes of select management strategies. Findings to date reveal significant opportunities for improving the institutional resilience of the US Forest Service.

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### **Seedlings and suckers, stands and clones – so you think you know aspen?**

James Long, Professor of Silviculture and Forest Ecology, and Karen Mock, Associate Dean, Quinney College of Natural Resources, Utah State University, Logan, Utah

The conventional view of regeneration ecology of western aspen (*Populus tremuloides* Michx.) has been that regeneration is, under almost all circumstances, dependent on suckering following stand-replacing disturbance. This view has fundamentally shaped, in ways both dramatic and subtle, the way aspen is managed. Recent research, however, is changing our understanding of aspen regeneration ecology, genetic diversity, and stand dynamics. With this increased understanding comes an opportunity to revisit some of our long-held views concerning aspen silviculture.

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*James N. Long is professor of forest ecology and silviculture in the Quinney College of Natural Resources and Ecology Center at Utah State University. He works on the production ecology of coniferous forest and quantitative silviculture. Much of this work involves development and implementation of strategies to achieve desired future stand conditions for a variety of resource objectives. His last sabbatical leave was at the University of Turin, Italy.*

*Karen E. Mock is an associate professor in the Wildland Resources Department in the Quinney College of Natural Resources and the Ecology Center at Utah State University. Her research is in conservation genetics and molecular ecology of a wide variety of plant and animal species. Much of her recent work has been focused on aspen regeneration ecology.*

### **Mapping evidence of historical and potential wildfire for climate change and fuels mitigation in the montane forests of the Colorado Front Range**

Rosemary Sherriff, Associate Professor, Humboldt State University, Arcata, California

A driving factor for fuels reduction is the belief that increases in woody biomass have resulted in a greater risk of severe wildfire. In this research, we compared spatial models of present-day wildfire potential under extreme (99th percentile) weather scenarios and historical fire severity in a >562,000 ha study area in the Colorado Front Range characterized by ponderosa pine and mixed conifer cover types. We then verified these models using fire severity from four large recent fires, and then compared the wildfire potential models to a spatial model of historical fire severity. The model of historical fire severity was based on data from 232 fire history-age structure sites in which topographic variables were used to predict the spatial pattern of historical fire severity across the study area. Under extreme weather conditions, approximately one-third of the study area exhibited the potential for low-severity (surface) fire and two-thirds showed the potential for mixed-severity (torching to

crown) fire. The results indicate strong spatial overlap of reconstructed fire regimes and present-day wildfire potential: crown fire potential today is associated with higher-severity fire historically (>80% overlap). Our results indicate <20% of the area has shifted from an historical low-severity fire regime to present-day risk of higher severity under extreme weather conditions. The areas of greatest change are at low elevation, and along the plains-grassland ecotone, where there have been substantial changes related to grazing and fire-exclusion policies. As the temperatures under extreme conditions from ca. 1964-2007 are similar to 39th percentile conditions predicted by the IPCC for 2100, the extreme fuel conditions described in this study are likely to become average conditions in the future.

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*Rosemary Sherriff is an Associate Professor in the Department of Geography and Faculty in the Departments of Environmental Studies and Forestry and Wildland Resources at Humboldt State University. She received a B.S. degree in Geography from the University of Oregon, and an M.A. and a Ph.D. in Geography from the University of Colorado, Boulder. Her research and teaching interests include biogeography, landscape and disturbance ecology, climate change and ecosystem management. Her current research activities focus on understanding past and present effects of climate change and disturbance on forest ecosystems in Colorado, southwest Alaska and northern California that are relevant for current and future land-use management.*

### **Beaver: Restoration liaison between riparian and upland systems**

Joe Wheaton, Assistant Professor and Fluvial Geomorphologist, Utah State University, Logan, Utah

Beaver (*Castor canadensis*), well known for their dam-building ecosystem engineering activities and potential as a nuisance species, are increasingly being used as a restoration agent and conservation tool to restore dynamism in streams and create better habitat for a variety of threatened biota. Beaver don't build dams everywhere, but where they can, they are a potentially cheap alternative to restoring degraded stream habitats. Beaver will harvest dam building materials and forage up to 150 meters away from their ponds, and this activity extends their zone of influence from just within streams and riparian areas up into uplands. Their harvesting activities mimic that of a rotational crop farmer, where instead of decimating and clear-cutting an area, they selectively forage and work an area hard for a number of years, before resting it and moving elsewhere. The vegetative response (particularly of aspen forests) to this disturbance typically results in a more diverse and vigorous regrowth. Examples of restoring streams with beaver will be shared that highlight how beaver can reconnect incised channels with their former floodplains, expand riparian areas into uplands, and invoke population level responses in salmon. Beyond that, a model that predicts the capacity of the landscape to support dam-building activity by beavers will be presented that helps build realistic expectations about where beaver may or may not be appropriate restoration agents. These examples will be brought together with some suggestions of how upland and riparian restoration efforts can feed off each other with the help of beaver.

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*Joe Wheaton is an Assistant Professor at Utah State University and a fluvial geomorphologist with over a decade of experience in river restoration. Joe runs the Ecogeomorphology & Topographic Analysis Lab in Utah State University's Department of Watershed Science and is a leader in the monitoring and modeling of*

*riverine habitats and watersheds. He is the co-director of the Intermountain Center for River Rehabilitation & Restoration. He worked four years in consulting engineering before completing his B.S. in Hydrology (2002, UC Davis), an M.S. in Hydrologic Sciences (2003, UC Davis), and a Ph.D. in Geography (2008, University of Southampton, UK). He worked as a lecturer in Physical Geography (University of Wales 2006-08), Research Assistant Professor in Geology (Idaho State University, 2008-09) before becoming an Assistant Professor at Utah State University (2009-present) where he teaches courses on geomorphology, fluvial hydraulics, ecohydraulics, GIS, geomorphic change detection, and river restoration.*

### **The many faces of quaking aspen: Biogeography meets resilience management**

Paul Rogers, Director, Western Aspen Alliance, and Adjunct Faculty, Department of Wildland Resources, Utah State University, Logan, Utah

Managers and scientists alike commonly practice quaking aspen (*Populus tremuloides* Michx.) management with a “one-size-fits-all approach” based a simple successional model: aspen as the “pioneer” species is overtaken by locally dominant conifers as time increases post-disturbance. We now know that aspen reacts to disturbance at various scales, along multiple pathways. How might this realization affect a more informed management/restoration approach? We examine a variety of aspen types as ecological systems; not exclusively seral dynamics and single species management. The framework presented here distinguishes three first-order “functional types” with a total of seven embedded second-order “subtypes”: Seral (boreal, montane), Stable (parkland, Colorado Plateau, elevation/aspect limited, terrain isolated), and Mixed Seral-Stable (riparian). This presentation draws from a larger review paper on aspen functional types to describe unique disturbance processes in varied geographic settings. Important features of these distinctions include physiological and climate conditions, stand structures and dynamics, and disturbance types and periodicity. The talk will briefly look at confounding factors—such as past management, ungulate herbivory, and climate futures—that impact the functionality of aspen disturbance regimes. Finally, the discussion will explore appropriate short- and long-term management considerations for each of the aspen sub-types. The quaking aspen framework lends itself to future management and research courses that seek to emulate ecological processes rather than alter or control them. There is potential for applying a functional approach to other vegetation types (e.g., ponderosa pine, sagebrush, short-grass prairie) whose wide geographic ranges engender diverse adaptations, as well as management responses.

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

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## **Climate change and forest disturbance: The case of the mountain pine beetle**

Barbara J. Bentz, Research Entomologist, USDA Forest Service, Rocky Mountain Research Station, Logan, Utah

Forecasts of climate change raise concerns about future modifications to forest ecosystem composition, structure and dynamics. Distributions of some tree species are also predicted to change with alterations in abiotic conditions and possible repercussions to biotic interactions. Native bark beetles in the genus *Dendroctonus* have historically played important roles in forest ecosystem dynamics through their influence on patterns of tree mortality. Climate change is predicted to influence *Dendroctonus* populations, thereby affecting community dynamics and succession pathways of forest ecosystems. In susceptible forests, climatic changes influence bark beetle populations directly through effects on beetle physiology, and indirectly through effects on host trees. The direct and indirect influences of temperature and precipitation on population outbreak dynamics is complex, however, and can result in both positive and negative feedbacks to beetle population success. To predict spatial and temporal patterns of future tree mortality, and evaluate future forest resiliency capacity, it is necessary to understand the climate-driven processes that influence beetle population success. I will discuss field, laboratory, and model-derived data that describe physiological processes driving potential response of *Dendroctonus ponderosae*, the mountain pine beetle, in a changing climate. Connecting models of thermally-driven bark beetle population dynamics and forest ecosystems will also be discussed.

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*Barbara Bentz has been a Research Entomologist with the USDA Forest Service, Rocky Mountain Research Station in Logan Utah since 1992. Her research is focused on native bark beetles that infest conifers across western North America. The influence of temperature on bark beetle population dynamics has been a primary research topic throughout her career, laying a foundation for current research on predicting climate change effects in forest ecosystems. Research on genetic differences in thermal traits among populations within a species contributes to understanding species response in a changing climate. Collaboration with mathematicians provides avenues for development of predictive, process-based models of bark beetle thermal-response that are important in management of future forests. Additional research has focused on mutualistic fungi associated with bark beetles, bark beetle response to fire injured trees and their role in avian habitat suitability, bark beetle population monitoring, and semiochemical strategies for population suppression. Dr. Bentz is an adjunct member of the Wildland Resources Department at Utah State University.*

## **Management lessons from recent aspen declines and climate**

James J. Worrall, Forest Pathologist, USDA Forest Service, Rocky Mountain Region, Gunnison, Colorado

Trembling aspen recently experienced extensive crown thinning, branch dieback, and mortality across North America. Most decline regions experienced exceptionally severe drought preceding these episodes. Decline tended to occur in marginally suitable habitat, and climatic suitability decreased markedly in the period leading up to decline in almost all decline regions. Other factors, notably multi-year defoliation by tent caterpillars and stem damage by fungi and insects, also play substantial roles in decline episodes. Many severely affected stands have poor regeneration potential, raising concerns that increasing aridity could ultimately lead to widespread loss of aspen forest cover. The analysis indicates that exceptional droughts were a major cause of the decline episodes, especially in the drier regions, and that aspen is sensitive to drought in much of its range. Models suggest that we should expect substantial loss of suitable habitat within the current distribution, especially in the

USA and Mexico. Particularly in the interior western U.S., the results provide support for aspen management. Further, they suggest approaches for deciding where to invest in management under changing climates, taking advantage of the diversity offered by changes in elevation and aspect.

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# Poster Abstracts

In alphabetical order by presenting author's last name,  
presenting author in italics

## **Collecting tree seed in hot, dry places: Do progeny of these trees have drought tolerance and water-use efficiency needed for restoration of harsh sites?**

*John-Pascal Berrill*, and *Christa M. Dagley*, Humboldt State University, Arcata, California

Trees growing in the hottest/driest parts of their natural range may be better-adapted to hot, dry conditions and hold promise for restoration and resistance to climate change. If drought tolerance and water-use efficiency were heritable traits, we could select for these characteristics and raise seedlings for reforestation on marginal sites or in areas where adverse changes in climate were forecast. We sought to quantify heritability of these traits in coast redwood, a species with limited range and thought to be dependent on moist soils and mild summer temperatures moderated by coastal fog. The species is threatened by declining fog and warming trends at the drier extremes of its range, inland and to the south. We collected seed on dry ridges and upper slopes from the southernmost populations and inland locations where redwood experiences the hottest summertime temperatures. Our expectation was that - when planted on drier sites - their offspring would outperform seedlings from moister, more northern, coastal locations. Conversely, we expected seedlings adapted to moister locales to outperform the 'dry site' redwoods when planted on moister northern sites.

Coast redwood seedlings from southern/dry sites (from Monterey to Napa Counties), central sites (Mendocino County), and northern sites (Humboldt County) were outplanted in a replicated interlocking hexagonal experimental design, at a cool, wet northern coastal site and a hot, dry, high-elevation site (outside of redwood's natural range) in Humboldt County, and at a hot, dry site in Mendocino County, California. A total of almost 3000 seedlings were planted by Humboldt State University students in 2010 and 2011. Seedling health status and height have been measured repeatedly. The experiment will continue to provide insights into outcomes of reclamation and "assisted migration" forest conservation/restoration strategies and the impact of climate change on regional sub-populations better- or worse-adapted to the new climate. A portion of the seed collected from each tree is in long-term storage at the state seed bank in Davis, California, to conserve their genes. This will allow for future tree breeding or restoration of vulnerable, isolated, small populations at the fringes of their natural range. This presentation describes the seed collection procedure and field experiment design, and shows how hundreds of students studying forestry and ecological restoration have been actively involved in this long-term study.

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## **Whitebark pine restoration strategy for the US Forest Service Pacific Northwest Region**

*Andrew Bower*, Olympic National Forest, Olympia, Washington

There are over 1.1 million acres of whitebark pine habitat in Oregon and Washington, 96% of which is on US Forest Service land. The US Forest Service Pacific Northwest Region (OR and WA) has allocated substantial financial and human resources in efforts for conservation and restoration of whitebark pine. These efforts have followed a plan outlined in a document titled the "Whitebark Pine Restoration Strategy for the Pacific Northwest Region" which presents a comprehensive 5-year plan to reach the goal of "a network of viable

populations of whitebark pine throughout the Pacific Northwest.” The key actions prescribed include: collect seed for gene conservation and rust resistance screening; assess stand conditions in priority management units; develop plans for planting seedlings in priority management units; continue a rust screening program with emphasis on seed zones in grizzly bear areas; treat for mountain pine beetle in high risk management units; develop an approach for planting seedlings in designated wilderness areas; develop an approach to mitigate the predicted impacts of climate change. Highlights of some of the activities that have been undertaken as prescribed in this strategy will be discussed.

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### **SEEDZONE MAPPER: A mapping & planning tool for plant material development, gene conservation and restoration**

*Andrew Bower, Olympic National Forest, Olympia, Washington*

Deploying vigorous, well adapted, and ecologically appropriate plant materials is a core component of a successful restoration project. To better understand the genetics of adaptation and identify appropriate plant materials (e.g. seeds) for restoration, the USDA Forest Service, BLM, ARS and NRCS have generated considerable data from common garden studies and other research activities relating to seed zone development for key native species. In addition, climate-based provisional seed zones have been developed to assist practitioners in matching seed sources and planting site conditions as closely as possible when empirical genetic data are not yet available. The SEEDZONE MAPPER application allows a broad array of end-users to easily view and acquire available data on seed zones for use in plant material development and gene conservation and restoration activities. Data sources include species-specific seed zones from completed common garden studies as well as climate-based provisional seed zones. Client applications range in functionality from a simple geobrowser (requires only a web browser) to ArcGIS ArcMap, a full-feature GIS software platform that allows the user to integrate their own data and create map layouts. The SEEDZONE MAPPER application is available at: [http://www.fs.fed.us/wwetac/threat\\_map/SeedZones\\_Intro.html](http://www.fs.fed.us/wwetac/threat_map/SeedZones_Intro.html).

SEEDZONE MAPPER is part of a family of Wildland Threat Mapping (WTM) applications developed by WWETAC (USFS Western Wildland Environmental Threat Center, Prineville, OR) to portray the spatial interactions of wildland threats and high value resources that occur in wildlands. In WTM, users can evaluate seed zones in relation to other map services and wildland threats published by WWETAC such as climate change projections or wildfire risk. WTM can be accessed at: [http://www.fs.fed.us/wwetac/threat\\_map/index.html](http://www.fs.fed.us/wwetac/threat_map/index.html).

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### **Southern Rockies Fire Science Network: Supporting wildland fire science exchange from mesas to mountains**

*Tony Cheng, and Gloria Edwards, Colorado State University, Fort Collins, Colorado*

Wildland fire scientists and managers are faced with challenging conditions throughout the western intermountain region: widespread increase in population and housing, dramatic change and decline in forest

health, invasive weeds, combined with drought conditions and abundant forest fuel in areas characterized by shifting winds. Protection of human values must be balanced with the use of effective treatments in responsible natural resource management. In response to these issues, the Southern Rockies Fire Science Network (SRFSN) was created to support collaboration between managers and scientists, promoting application of credible science to on-the-ground fire management projects. SRFSN is one of 14 national consortia of the Joint Fire Science Program (JFSP), an interagency research, development, and applications partnership. Our newly expanded region includes eastern Utah, intermountain Colorado, southern Wyoming, and the Black Hills area of South Dakota.

SRFSN supports and develops workshops, presentations, field trips, webinars, demonstration sites, social media and digital communication with scientists, managers, and communities on critical wildland fire issues. These activities connect researchers, practitioners, and community groups to develop solutions for the WUI, watersheds, prescribed fire, and ecosystem restoration. SRFSN is actively seeking to develop fire science knowledge exchanges throughout our region. We recognize the need to involve fire experts, managers, and firefighters as well as the disciplines of wildlife, water, soils, air quality, recreation, range management, and social sciences. However, anyone with an interest in wildland fire, natural resource management, and community is invited and encouraged to participate!

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### **Effects of livestock removal in sagebrush ecosystems at Hart Mountain National Antelope Refuge, Oregon**

Lisa Ellsworth, and Boone Kauffmann, Oregon State University, Corvallis, Oregon

The sagebrush desert is among the most endangered ecosystems in western North America, due to land use changes such overgrazing by domestic livestock, invasive species, development, altered fire regimes, and changing climate, which often interact to affect ecosystem structure and function. The long-term effects of domestic livestock and patterns of recovery following their removal are poorly understood in sagebrush ecosystems. A unique opportunity exists to examine the effects of livestock removal at Hart Mountain National Antelope Refuge (HMNAR), which provides critical habitat for sage grouse and pronghorn antelope, and where cattle were removed to promote wildlife habitat in 1990. An understanding of the resultant changes in species composition, structure, and diversity will provide valuable information not only to refuge managers, but to land managers and other stakeholders in the Great Basin and semiarid west.

To address this issue, we obtained historical data and photos from permanently located plots and photo points (N=28) in four widespread communities: (1) Mountain shrub dominated by antelope bitterbrush (*Purshia tridentata*), mountain sagebrush (*Artemisia tridentata* subsp. *vaseyana*); (2) mountain big sagebrush (*A. tridentata* subsp. *vaseyana*); (3) Wyoming big sagebrush (*A. tridentata* subsp. *wyomingensis*); and (4) low sagebrush (*A. arbuscula*). All historical plots were previously measured in 1968, 1979, and 1987. We resampled and re-photographed all plots in 2013. Across all sagebrush ecosystem types there was a decrease in bare ground ( $P<0.01$ ) following cattle removal, with concomitant increases in shrub, native bunchgrass, and biological soil crust cover that varied by community type. Litter cover was lowest in 2013 ( $P<0.05$ ) than in any prior year. Cheatgrass and other exotic cover was minimal across all dates and communities, with  $<1\%$  cover present in plots, except for short-lived increases following 1985 fires in two plots. These findings demonstrate that the removal of livestock resulted in positive changes to critical sagebrush communities, and can inform management decisions where restoration of sagebrush habitat is a priority.

## **Aspen herbivory by wildlife and livestock on Utah's Monroe Mountain**

Jody A. Gale, Utah State University Extension, Richfield, Utah

In 2010, the Utah Department of Agriculture Grazing Improvement Program and Grand Canyon Trust convened a collaborative working group. Their objective was to develop recommendations to address decreasing regeneration and recruitment of aspen (*Populus tremuloides*) on Monroe Mountain in the Fishlake National Forest in central Utah. Multiple land-use interests represented in the collaborative included: livestock, wildlife, private inholdings, conservation, etc. Decreasing populations of aspen decrease ecosystem biodiversity, forest health, habitat, water quality, water yield, and other societal values. A major cause of aspen decline is the long-term lack of stand-replacing disturbance by fire, disease, or harvest, which allows overtopping of aspen by conifers. Following disturbance, chronic herbivory of aspen sprouts by wildlife and livestock threatens clone viability. Livestock were implicated by some interests and wildlife by others as the primary cause of aspen herbivory with no scientific evidence to support claims. In 2011, members of the collaborative established 4, non-replicated, non-randomized, 6'x100' belt transects to measure herbivory of aspen sprouts pre-and post-livestock grazing. To record which herbivores were active in transects, digital trail cameras, equipped with motion and infrared sensors, were positioned at each end facing each other. Over 60,000 photographs and video clips documented herbivory by domestic beef (*Bos primigenius*), elk (*Cervus canadensis*), and deer (*Odocoileus hemionus*); and recorded other environmental, wildlife and human activity. Data show elk, beef and deer all actively grazing in the transects. The highest percentage of sensor triggers by elk was at the Tibadore (63%; 2011) and Burnt Flat (39%; 2012). Highest triggers by beef were at Burnt Flat (62%; 2011), Squaw Springs (53%; 2011), and Tibadore (48%; 2012). Highest triggers by deer were at Squaw Springs (60%; 2012), White Ledges (59%; 2012 and 52%; 2011). Browsing of aspen leaders by all three animal species during the livestock grazing period in 2011 ranged from 13% at Tibadore to 58% at Burnt Flat and Squaw Springs with three of four transects exhibiting 52-58% browsing. In 2012, percent browsing ranged from 65% at Tibadore to 91% at Burnt Flat.

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## **Natural regeneration of whitebark pine: Factors affecting seedling density across Idaho, Montana, and Wyoming**

Sara A. Goeking, Rocky Mountain Research Station, Ogden, Utah, and Deborah K. Izlar, Pacific Northwest Research Station, Anchorage, Alaska

Whitebark pine (*Pinus albicaulis*) is an ecologically important species in high-altitude areas of the West due to the food source it provides for Clark's nutcrackers, red squirrels, grizzly bears, and other animals. Whitebark pine stands have recently experienced high mortality due to wildfire, white pine blister rust, and a mountain pine beetle outbreak, leading several researchers and managers to question the species' long-term viability. This study examined regeneration at over 1,000 Forest Inventory and Analysis (FIA) plots containing a whitebark pine component (i.e., any dead whitebark pine trees larger than 5 inches d.b.h. or live whitebark pines of any

size) in the northern Rocky Mountains. Objectives were to characterize the population's age and size structures, as well as identify factors that influence whitebark pine regeneration. Mean seedling density at FIA plots ranged from zero to over 3,000 seedlings per acre, with a mean density of about 300 seedlings per acre and a median density of about 110 seedlings per acre. At the landscape scale, whitebark pine's age classes and size classes both show a steep reverse-j distribution. A two-stage modeling approach was used to relate site-specific and climate variables first to presence/absence of whitebark pine seedlings, and then to seedling density. Preliminary results suggest that regeneration is most strongly related to the density of understory vegetation, particularly the shrub *Vaccinium scoparium*, as well as seedling density of other tree species. Species composition of the overstory was more important than indicators of overstory density, including tree canopy cover and basal area. With respect to temperature and precipitation, the relative importance of mean versus variability metrics differed by season.

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### **Grass-shrub spatial patterns over moisture and grazing gradients in Great Basin sagebrush communities: Insights into restoration and climate change**

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Restoration efforts in the highly disturbed Great Basin ecosystem have historically focused on re-establishing the native herbaceous understory after sagebrush removal. A more effective approach may be to target areas where canopies are left intact and seeds/seedlings are planted in shrub interspaces or shrub canopies. In this context, shrub canopies may facilitate the growth of native perennial species, or alternatively seeds/seedlings may thrive in interspaces due to reduced woody competition. In the Great Basin, there is some evidence that positive perennial grass-shrub associations occur between Wyoming big sagebrush and native grasses. We are investigating the response of these grass-shrub spatial associations to moisture and grazing gradients in the Great Basin. We hypothesized that grass-shrub spatial associations would become more pronounced as rainfall level decreased and grazing intensity increased. Specifically, we wanted to determine how the spatial association between Wyoming big sagebrush and two Great Basin perennial grasses, *Poa secunda* and *Elymus elymoides*, changed in response to a landscape-scale rainfall gradient and a grazing gradient. We sampled 29 sites in three states (Utah, Idaho, and Nevada) with different annual rainfall levels (low, medium and high) and grazing intensities (low and high). We used an individual shrub sampling method to determine percent cover of *Poa secunda* and density of *Elymus elymoides* in shrub canopies and interspaces. We used a regression approach to model the response of percent cover of *Poa secunda* in canopy, interspace, and edge regions to rainfall level. Preliminary results show that as rainfall increases, percent cover of *Poa secunda* in canopies remains relatively constant at 6%. However, the response of percent cover in the interspace is much stronger; as rainfall level increases, percent cover of *Poa secunda* increases from 2% at low rainfall levels to 10% at high rainfall levels. Analyses regarding the grazing gradient are pending. Better understanding of plant spatial patterns over stress gradients can aid in determining appropriate microsite planting locations for perennial grasses in ecological restorations and help predict vegetation responses to climate change.

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## Historic quaking aspen fire regimes in Utah (USA) forests

Stanley G. Kitchen, USDA Forest Service, Rocky Mountain Research Station, Provo, Utah

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

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

Kevin D. Krasnow, Conservation Research Center, Teton Science Schools, Jackson, Wyoming and University of California, Berkeley, California

Aspen (*Populus tremuloides*) is considered a foundation species and adds significant biological diversity to conifer-dominated western forests, yet represents less than 1% of forest cover in the Sierra Nevada. Aspen are also particularly sensitive to climate, and are currently a species of concern due to wide-scale, drought-induced mortality in the Intermountain West, declining vigor of current populations in the Sierra Nevada, and predictions of increased aridity in the next century. 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 (3 sites of conifer removal, 2 sites of prescribed fire) and compares these treatments with recent wildfires (4 sites, each randomly stratified by fire severity). Experimental questions include:

**Resistance Strategies:** *Are prescribed fire and conifer removal restoration treatments effective in stimulating asexual aspen regeneration (sprouting)? How do these simulated disturbances 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 models show that both conifer removal and prescribed fire can be effective restoration

treatments but that unplanned wildfire produces significantly higher ramet (sprout) density than either treatment. Conifer removal was found to be ineffective in one site where heavy aspen over-story mortality was observed 2 years post-treatment. Sun-induced aspen bole damage and spatial dependence between aspen mortality and removed conifers indicates sunscald as the mortality agent, and provides conifer thinning guidelines for future treatments. 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 in these study sites. Five sites of aspen seedling establishment were identified in recently burned areas. All seedling sites were in areas of high fire severity, high soil moisture, concave micro-topography, and high incident solar radiation. The ability of aspen to migrate in order to accommodate climate change will depend heavily on the occurrence of high severity fire and successful seed dispersal to microsites that will allow successful seedling establishment.

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### **Great Basin Fire Science Delivery**

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The Great Basin Fire Science Delivery project ([www.gbfiresci.org](http://www.gbfiresci.org)) links managers and scientists to improve pre- and post-fire management decisions by providing relevant information and access to technical expertise. This project is one of 14 regional Knowledge Exchange Consortia funded by the Joint Fire Science Program ([https://www.firescience.gov/JFSP\\_consortia.cfm](https://www.firescience.gov/JFSP_consortia.cfm)). The goals of the project are to: 1) provide a forum where Great Basin land managers can identify technical needs with respect to fire, fuels, and post-fire vegetation management; 2) develop and synthesize the information and technical tools to meet these needs; 3) provide the information and technical tools through preferred venues; and 4) develop direct lines of communication between managers and scientists. The project is currently sponsoring five syntheses and related field guides that are focused on sagebrush and pinyon/juniper ecosystems and address effects of fire on vegetation and hydrology, effects of livestock grazing on fuel loads, and wind erosion and post-fire stabilization. We recently held a field tour on 30 years of western juniper management led by regional experts and are beginning a new webinar season with topics that include effects of pinyon and juniper harvesting on water balance, effectiveness of Emergency Stabilization and Rehabilitation seeding, seed zones and climate change, and effects of drill type on seeding success. The project continues to support online training opportunities at University of Idaho. We expect public and private land managers to benefit from this project by having a place and a person to turn to for answers to technical questions, leads to research contacts, and a forum to communicate technical needs. We expect research scientists to benefit by gaining new ideas and partnerships for research and by providing new methods of outreach for research results.

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### **Resilience of novel riparian forests of the regulated Missouri River**

*Malia Volke* and W. Carter Johnson, South Dakota State University, Brookings, South Dakota

Cottonwood forest regeneration has sharply declined along the Missouri River and other western U.S. rivers due primarily to flow regulation by dams. Novel river habitats, including delta formations where tributaries empty into reservoirs, are one of the few places along the Missouri River where there is successful cottonwood regeneration. The delta formed at the confluence of the White River and Fort Randall Reservoir in South Dakota represents such a novel habitat. Time-series analysis of riverine cross-sections indicated that there has been a trend of channel and floodplain aggradation within the postdam delta, facilitating expansion of delta surfaces into and above the reservoir pool. Likewise, time-series analysis of aerial photography showed that forest area increased by 69 percent in the postdam era. Field inventories determined that a heterogeneous mixture of cottonwood forests exists within the White River delta region, and that the composition and structure of these forests differs from those along natural river reaches. Although there has been an overall trend of increasing forest area, turnover of forest patches is common, especially for patches at the lowest elevations vulnerable to prolonged reservoir inundation. Flooding of the expanding delta has increased over the last two decades and is likely to become more typical in the future due to climate change and ageing of the reservoir system, including formation of larger deltas and reduced reservoir storage capacity. Knowledge of the existing vegetation patterns and morphology of the White River delta can reveal how reservoir pools could be managed to favor the expansion and survival of delta forests over the long-term.

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