

RESTORING THE WEST 2009

*Peaks to Valleys: Innovative Land
Management for the Great Basin*

October 27 & 28, 2009
Utah State University
Logan, Utah

Conference Organizing Committee

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Agenda

Tuesday, October 27	
USU Eccles Conference Center Auditorium	
7:30 to 8:15 am	Registration; coffee and juice provided
8:15 to 8:30 am	<i>Welcome. Darren McAvoy</i> , Utah State University Forestry Extension Associate, and Nat Frazer , Dean of the College of Natural Resources, Utah State University
8:30 to 8:45 am	Leonard Blackham : Utah Commissioner of Agriculture and Food - <i>Opening Address</i>
8:45 to 9:30 am	Keynote speaker: Don Grayson , Professor, University of Washington - <i>Putting the Past to Work: Archaeological Approaches to the Future of Great Basin Mammals</i>
9:30 to 10:00 am	Bob Nowak , Professor, University of Nevada, Reno - <i>Ecohydrology in the Great Basin: Plants and Water in Arid Ecosystems</i>
10:00 to 10:30 am	Break
10:30 to 11:00 am	Mark Brunson , Department Head and Professor, Utah State University - <i>Myth, Metaphor, and the Social Dimensions of Restoration in the Great Basin</i>
11:00 to 11:30 am	Jeanne Chambers , Research Ecologist, USDA Forest Service, Rocky Mountain Research Station, Reno, and Jim Grace , Research Ecologist, U.S. Geological Survey, National Wetlands Research Center - <i>Understanding Resistance to Invasion and Resilience to Disturbance – the Key to Restoring Great Basin Ecosystems?</i>
11:30 to 12:00	Jack Schmidt , Professor, Utah State University - <i>River Restoration in the Great Basin - What Can We Really Hope to Achieve?</i>
12:00 to 1:30 pm	Lunch and Poster Session - ECC Lobby and Rooms 205-207
1:30 to 2:00 pm	Brett Roper , Aquatic Ecologist, USDA Forest Service and Utah State University - <i>Restoring Native Fish Species in the Great Basin</i>
2:00 to 2:30 pm	Matt Germino , Associate Professor, Idaho State University, and Beth Leger , Assistant Professor, University of Nevada, Reno - <i>Exotic and Native Herbs in Sagebrush Steppe: Diagnoses, Prognoses and Prescriptions for Restoration</i>
2:30 to 3:00 pm	Frank McCormick , Program Manager, Air, Water and Aquatic Environments Science Program, USDA Forest Service, Rocky Mountain Research Station, Boise - <i>Assessing Risk to Aquatic Systems</i>
3:00 to 3:30 pm	Break
3:30 to 4:00 pm	Annie Loosen , Teton Science Schools - <i>An Approach to Landscape Scale Aspen Inventory and Assessment: Applications for the Great Basin</i>
4:00 to 4:30 pm	Peter Weisberg , Associate Professor, University of Nevada, Reno - <i>Pinyon and Juniper Woodland Expansion: Can a Historical Perspective Guide Management of Future Landscape Change?</i>
4:30 to 5:00 pm	Julie Stromberg , Associate Professor, Arizona State University, and Duncan Patten , Research Professor, Montana State University - <i>Riparian Ecology and Restoration in the Arid and Semiarid West: Lessons Learned</i>
5:30 to 7:30	Evening social at Cafe Sabor (600 W Center St., Logan)

Agenda, continued

Wednesday, October 28 USU Eccles Conference Center Auditorium	
8:00 to 8:30 am	Coffee and juice provided
8:30 to 8:45 am	<i>Announcements and Day Two Preview.</i> Darren McAvoy , Utah State University Forestry Extension Associate.
8:45 to 9:30 am	Julio Betancourt , Senior Scientist, National Research Program, Water Resources Division, U.S. Geological Survey - <i>Climate Variability, Climate Change, and Large-scale Ecological Responses: Challenges for Ecosystem Science and Management in the West</i>
9:30 to 10:00 am	Connie Millar , Research Paleoecologist, USDA Forest Service, Pacific Southwest Research Station - <i>Adapting to Climate Change in Great Basin Mountain Ecosystems</i>
10:00 to 10:30 am	Break
10:30 to 11:00 am	Andrea Brunelle , Associate Professor, University of Utah - <i>An Introduction to Paleoecological Data and their Utility in Ecosystem Restoration</i>
11:00 to 11:30 am	Stan Kitchen , Research Botanist, USDA Forest Service, Rocky Mountain Research Station - <i>Historic Fire Regimes as Templates for Fire Restoration in Eastern Great Basin Mountains - or: Eating the Elephant a Bite at a Time</i>
11:30 to 12:00 pm	Patty Champ , Economist, USDA Forest Service, Rocky Mountain Research Station - <i>Pricing the Priceless: Valuing Nonmarket Goods and Ecosystem Services</i>
12:00 to 1:00 pm	Lunch
1:00 to 1:30 pm	Jack Connelly , Principal Wildlife Research Biologist, Idaho Department of Fish and Game - <i>Sage-grouse and Fire: Smokey the Bear Was a Good Guy</i>
1:30 to 2:00 pm	Carl Wambolt , Emeritus Professor, Range Science, Montana State University - <i>Fire Ecology of Sagebrush Systems: To Burn or Not to Burn for Wildlife Habitat</i>
2:00 to 2:30 pm	Dean Pearson , Research Ecologist, USDA Forest Service, Rocky Mountain Research Station - <i>Ecology and Management of Invasive Species</i>
2:30 to 3:00 pm	Kate Dwire , Research Riparian Ecologist, USDA Forest Service, Rocky Mountain Research Station - <i>Wildfire and Fuel Treatments in Riparian Areas of the Interior West</i>
3:00 to 3:30 pm	Break
3:30 to 4:30 pm	<i>Panel Discussion.</i> Moderator: Mark Brunson , Department Head and Professor, Utah State University
4:30 to 5:00 pm	Ron Ryel , Associate Professor, Utah State University - <i>Perspectives on Future Directions for Management and Restoration in the West</i>
5:00 pm	Adjourn

Speaker Abstracts

In order of presentation,
presenting author in italics

Putting the Past to Work: Archaeological Approaches to the Future of Great Basin Mammals

Donald K. Grayson, University of Washington, Seattle, WA

The Great Basin has provided some of the most detailed sequences of mammal history from anywhere in the world for the past 11,000 radiocarbon (13,000 calendar) years. Many of these sequences have been provided by the analysis of vertebrate remains from carefully-excavated archaeological sites, augmented by faunal assemblages provided by paleontological sites and packrat (*Neotoma*) middens. These sequences can be combined with local climate and vegetation histories, often obtained from the same locations that provided the vertebrate remains. This analytic combination provides a longer-term view of the interactions among climate, vegetation, and mammal distributions and abundances than can be gained from direct historic observational data, at the expense of the details provided by studies of contemporary mammals. This approach can be used to: 1) understand how mammals responded to climate and vegetation change in the past, 2) predict how they are likely to respond to similar changes in the future, 3) determine the feasibility of reintroductions, and 4) distinguish translocations that are reintroductions from those that are novel introductions. The biogeographic histories of four species within the Great Basin are used to illustrate the contributions that this approach can make to understanding the past and managing the future: pikas (*Ochotona princeps*), pygmy rabbits (*Brachylagus idahoensis*), bison (*Bison bison*), and elk (*Cervus elaphus*).

Donald K. Grayson, Department of Anthropology, University of Washington, Box 353100, Seattle, WA, 98195, USA, Phone: 206-543-5240, Fax: 206-543-3285, Email: grayson@u.washington.edu

Donald K. Grayson is Professor of Anthropology (Archaeology) in the Department of Anthropology and the Quaternary Science Center, University of Washington, Seattle. His research focuses on the paleoecology and human prehistory of the Great Basin and on human interactions with the biotic landscape during the Pleistocene of western Europe. He is the recipient of the Fryxell Award for Interdisciplinary Research from the Society for American Archaeology and the Nevada Medal from the Desert Research Institute. He is also the author of The Desert's Past: A Natural Prehistory of the Great Basin (Smithsonian Institution), soon to appear in a new edition.

Ecohydrology in the Great Basin: Plants and Water in Arid Ecosystems

Robert S. Nowak, University of Nevada-Reno, Reno, NV

Ecohydrology is the scientific discipline that examines interactions between the hydrologic cycle and ecosystems. Ecohydrology explicitly recognizes that the hydrologic cycle affects plants and that plants influence system hydrology. Using the Great Basin and its predominantly arid plant communities as a backdrop, I examine how hydrologic cycles influence plants at continental, regional, and localized scales. Both the amount and timing of both precipitation and potential evapotranspiration influence how the hydrologic cycle influences plants. Plants also influence water cycling and balance through plant influences on water redistribution in the soil profile and through species and microsite effects on soil water balance.

In the arid Great Basin environment, three ecohydrologic patterns emerge. First, with few exceptions, plants extract all available water from the soil profile during the growing season. Second, peak soil moisture occurs

relatively early in the growing season, well before peak standing crop. Third, maximum rooting depths are often greater than mean annual wetting depths of the soil profile. Hydrologic and ecologic implications of these patterns, including those related to restoration, groundwater recharge, and global environmental change, are discussed.

Robert S. Nowak, Department of Natural Resources and Environmental Science, University of Nevada-Reno, Reno, NV, 89557, USA, Phone: 775-784-1656, Fax: 775-784-4789, Email: nowak@cabnr.unr.edu

Bob Nowak has been studying plants in arid ecosystems for more than 30 years, starting with his M.S. and Ph.D. work under Professor Martyn Caldwell at Utah State University in the late 1970s and early 1980s. Trained as a plant physiological ecologist, he began “ecohydrology” studies before the discipline even existed during studies of plant water use at the Department of Energy’s Idaho National Laboratory while he was a postdoc in Jay Anderson’s lab at Idaho State University. Those studies of water use by Great Basin plants continued after moving to the University of Nevada, Reno in 1985 and expanded to include plants in the Mojave Desert during the 1990s. The main areas of focus for his lab today are impacts of global environmental changes on arid plants and their ecosystems and the ecology and management of invasive plants in arid ecosystems.

Myth, Metaphor, and the Social Dimensions of Restoration in the Great Basin

Mark Brunson, Utah State University, Logan, UT

The term “restoration” is fraught with subjective meanings that differ depending on the ecological knowledge and value orientations of those who hear or use it. For example, a manager might use the term to refer to activities such as herbicide application or mechanical removal of shrubs and trees, while some stakeholders might see those activities as pure destruction. In fact, “restoration” may be best understood not as a specific set of scientifically justified activities, but as a metaphor for activities which reflect the values of managers and are believed to reflect a wider value set of stakeholders. To test this perspective, I compared responses to public opinion surveys about management of rangelands in different parts of the West, including one survey where we experimentally manipulated the words used to describe activities commonly included as “restoration” practices. Results show that attitudes differ based on geography, threat perceptions, and experiences with land managers. Surprisingly, the language used to “frame” the restoration context was less influential.

Mark Brunson, Department of Environment and Society, Utah State University, 5215 Old Main Hill, Logan, UT, 84322-5215, USA, Phone: 435-797-2458, Fax: 435-797-4048, Email: mark.brunson@usu.edu

Mark Brunson is professor and head of the Department of Environment and Society at Utah State University. His research and writing focus primarily on the human dimensions of forest and rangeland science and management, including studies of public perceptions regarding wildlands and their management, communication and behavior change strategies, and the dynamics of coupled human-natural systems in arid and semi-arid environments.

Understanding Resistance to Invasion and Resilience to Disturbance – the Key to Restoring Great Basin Ecosystems?

Jeanne Chambers, USDA Forest Service, Rocky Mountain Research Station, Reno, NV, and **Jim Grace**, U.S. Geological Survey, National Wetlands Research Center, Lafayette, LA

Restoration ecologists and other applied ecologists are increasingly using the concepts of ecological resilience and resistance to aid in the restoration of disturbed ecosystems. Resistance is the ability of an ecosystem to

maintain characteristic processes despite various stressors or disturbance, while resilience is the capacity of an ecosystem to regain characteristic processes over time following stressors or disturbances. In the Great Basin, ecological resistance to non-native species often reflects the ecological amplitude of the invader or its ability to establish and persist. Ecological resilience or recovery potential typically increases over gradients of increasing available resources (water and nutrients) and net productivity. The ecological memory of an area coupled with the severity and frequency of disturbance and interactions among invasive species and disturbance regimes all influence ecological resistance and resilience. We illustrate these concepts based on our work with pinyon-juniper expansion and cheatgrass invasion into Great Basin ecosystems. We then discuss the use of these concepts for prioritizing management and restoration activities in these ecosystems.

Jeanne Chambers, USDA Forest Service, Rocky Mountain Research Station, 920 Valley Road, Reno, NV, 89509, USA, Phone: 775-0784-5329, Fax: 775-784-4583, Email: jchambers@fs.fed.us

Jeanne Chambers is a research ecologist with the USDA Forest Service, Rocky Mountain Research Station's Reno Lab. She received a master's degree in Range Science and a Ph.D. in Biology/Ecology from Utah State University. She began her employment with RMRS in 1983 on the Disturbed Land Restoration Project here in Logan. In 1992 she moved to Reno where she has served as the Team Leader of an Ecosystem Management Project for Restoring and Maintaining Great Basin Watersheds and Riparian Ecosystems. Her research focuses on: 1) disturbance/restoration ecology, 2) global change processes, 3) invasive species, and 4) semi-arid watersheds and riparian ecosystems.

Jim Grace obtained his Ph.D. from Michigan State University and has served on the faculties at the University of Arkansas and Louisiana State University. He is currently a Senior Scientist with the U.S. Geological Survey in Lafayette, LA and holds an Adjunct Professorship in Biology at the University of Louisiana. At present, he has collaborations involving an array of topics, including studies on climate change impacts, fire ecology, monitoring in our National Parks, and African ecosystems.

Restoring Native Fish Species in the Great Basin

Brett Roper, USDA Forest Service and Utah State University, Logan, UT

The aquatic species within the Great Basin are diverse and unique but face threats similar to other aquatic species throughout the United States. Those threats include habitat degradation, exotic species, water uses, and an increasing number of humans choosing to live in the region. Aquatic restoration effort in this region can be either simpler or more complex than in other regions depending upon the species and its habitat. The simplicity comes from the large amount of public land and the relative low human population density within the Basin. The difficulty lies with this being one of the driest regions in this nation and the increasing demand on limited water resources. Types of successful restoration efforts range from the small scale of maintaining springs to the large scale of reconnecting disconnected stream habitats.

Brett Roper, USDA Forest Service, Forest Sciences Laboratory, Fish and Aquatic Ecology Unit, 860 North 1200 East, Logan, UT, 84321, USA, Phone: 435-755-3566, Fax: 435-755-3563, Email: broper@fs.fed.us

Brett Roper is currently the National Aquatic Monitoring Program Manager for the USDA Forest Service and is an Adjunct Professor for the Watershed Sciences Department at USU. He received his Ph.D. in fisheries from the University of Idaho and a masters in forestry from Utah State University. Most of Brett's past and current research efforts have focused on better understanding the relationship between land management actions, stream processes, and fisheries population dynamics.

Exotic and Native Herbs in Sagebrush Steppe: Diagnoses, Prognoses, and Prescriptions for Restoration

Matt Germino, Idaho State University, Pocatello, ID, and **Elizabeth Leger**, University of Nevada-Reno, NV

Changes in abundance and species composition of herbaceous communities have been some of the most profound environmental changes in the western U.S. Conversion of native perennial to annual herb monocultures that may progress towards exotic herb communities is common across a wide range of hydroclimatological conditions. In the Intermountain West, these conditions range from red brome in warm deserts, to cheatgrass in sagebrush steppe, to smooth brome and tarweed in higher elevations. These vegetation changes are all linked to land uses, and are reinforced by plant-soil or fire feedbacks that are linked to the desertification process. The feedbacks have ultimately impeded long-term restoration efforts.

New perspectives and approaches are needed in dealing with invasive herbs and are fortunately under development in a variety of agency and university programs. New perspectives may entail re-evaluation of species like sagebrush that normally are not viewed as having agro-economic merit in rangelands, but may have important implications for exotic-herb invasion and diversity of native herbs. Observations from protected communities on kipukas and other preserves offer important insights on floristic tendencies of sagebrush steppe. Opportunities exist to enhance post-fire rehabilitation and re-vegetation and management of fuels and invasives, particularly with respect to short-term soil exposure and long-term plant community health. Opportunities also exist for introducing concepts from evolutionary ecology to improve native plant materials for restoration, such as propagation and increase of natives that persist with cheatgrass. The most transformative and comprehensive advances will likely result from improved coordination guided by new programs such as the Great Basin Research and Management Partnership and USDA Bromus network. Effective management of widespread issues of exotic invasions and native plant diversity will require continued efforts to cross agency, university, geographic, and disciplinary boundaries to enable adaptation of land management.

Matthew J Germino, Department of Biological Sciences, Idaho State University, 921 S 8th St - Mail Stop 8007, Pocatello, ID, 83209-8007, USA, Phone: 208-282-5680, Email: germmatt@isu.edu

Matt Germino specializes in the Biophysical and Physiological Ecology of Plant Communities, with an emphasis on forest and shrub-steppe habitats. He received his Ph.D. from the Botany Department at University of Wyoming in 2000 and is currently an Associate Professor at Idaho State University. His teaching and research program spans a wide range of disciplines in plant biology and ecology at scales ranging from the cell to ecosystems. In forests, his research group addresses problems of climate, carbon balance, and tree establishment in the context of understanding forest treeline boundary shifts. In the sagebrush-steppe, his lab emphasizes research leading to an understanding of causes and consequences of species change, particularly with respect to hydroclimatological and land use patterns.

Elizabeth Leger is a plant population ecologist at the University of Nevada, Reno. She did her graduate work at the University of California, Davis, receiving a Ph.D. in Ecology for work on the evolutionary ecology of invasive plants, and did a post-doc at SUNY Stony Brook. She has been faculty at UNR since 2006.

Assessing Risk to Aquatic Ecosystems

Frank McCormick, USDA Forest Service, Rocky Mountain Research Station, Boise, ID

Restoration of aquatic ecosystems in the West requires concerted efforts across multiple resources. Hazardous fuels treatments to reduce the likelihood and severity of wildfire; habitat restoration and improved aquatic

organism passage to reduce fragmentation of fish and amphibian populations; interdiction and eradication of invasive species; and reduction of sediment input from roads are only a few of the often competing priorities of land management agencies in the region. As a changing climate and population migration places increasing demands on the water infrastructure, there will be greater pressures on federal, state, and tribal agencies to provide information and recommendations for meeting the mandates of environmental legislation such as the Clean Water and Endangered Species acts. Providing effective restoration options will require data on the status of aquatic resources and their vulnerability to the effects of human activities, natural disturbance, and climate change. Assessing the relative risk that aquatic ecosystems face from stressors could inform the prioritization and coordination of restoration efforts.

Frank McCormick, Program Manager, Air, Water, and Aquatic Environments, USDA Forest Service, Rocky Mountain Research Station, 322 E Front Street Suite 401, Boise, ID, 83702, USA, Phone: 208-373-4351, Email: fmccormick@fs.fed.us

Dr. Frank McCormick is the Program Manager of the Air, Water and Aquatic Environments program in the Rocky Mountain Research Station of the USDA Forest Service. He has 17 years of experience in managing natural resource programs as a research ecologist and program manager with the Environmental Protection Agency (EPA) and Forest Service. He worked with the EPA's Environmental Monitoring and Assessment Program (EMAP) and led assessments of watershed health and restoration, water availability, and quality. He conducted research on fish assemblages as indicators of ecological conditions in streams and rivers and the development of biological water quality criteria. He holds a doctorate in zoology from the University of Oklahoma and has research interests in fish and aquatic ecology.

An Approach to Landscape Scale Aspen Inventory and Assessment: Applications for the Great Basin

Annie Loosen¹, Steve Kilpatrick², Don DeLong³, Morgan Graham¹, and Brenda Younkin¹

¹ Teton Science Schools, Jackson, WY

² Wyoming Game and Fish, Jackson, WY

³ USDA Forest Service, Afton, WY

Aspen loss is widely documented across the West. In the Great Basin states, aspen loss has been estimated at 50% since European settlement. This decline is often attributed to a severe reduction in disturbance events, long-term over browsing, and disease. Aspen is widely noted for high understory productivity and diversity, high water yield, recreation, aesthetics and quality forage preferred by domestic and wild ungulates. Aspen communities are second in biodiversity only to riparian areas and consequently of great ecological significance. Aspen managers generally agree that treatment and wildfire management are necessary to maintain aspen health and distribution across the landscape. Furthermore, managers agree that time is of the essence for aspen communities in advanced successional status.

Working with a private entity, Wyoming Game and Fish and the USDA Forest Service developed a rapid aspen community inventory and assessment protocol for the Greys River Ranger District (GRRD) (484,752 acres). Technicians classified aspen stands according to community type, over and understory dominance, browse level, and risk factor. 48% of the total stands were classified as highest priority for treatment (27,419 acres), 33% of the stands were classified as moderate-high priority (14,742 acres), and five percent were classified as a candidate for properly functioning (2,140 acres). This protocol resulted in a GIS-based “road map” to aspen assessment and inventory that can be used by current and future GRRD managers to prioritize and implement treatments across an entire ranger district. Opportunities exist for the protocol developed for the GRRD to serve

as a useful template for managers across the Great Basin and much of the West to implement similar protocols to prioritize restoration efforts and future treatment options on their home districts.

Annie Loosen, Teton Science Schools – Conservation Research Center, 700 Coyote Canyon Road, Jackson, WY, 83001, USA, Phone: 307-413-2872, Fax: 307-734-1263, Email: Annie.Loosen@tetonscience.org

Annie conducts research for the Conservation Research Center of Teton Science Schools in Jackson, Wyoming. She contributed intensively to an aspen assessment and inventory project with Wyoming Game and Fish and USDA Forest Service-Afton in the Greys River Ranger District. Annie has been working on research and restoration projects since 2003, including native plant restoration with Red Butte Gardens in Salt Lake City, wolf habitat use in Southwest Alberta, and small mammal research in Western Siberia.

Pinyon-juniper Woodland Expansion: Can a Historical Perspective Guide Management of Future Landscape Change?

Peter J. Weisberg, University of Nevada-Reno, Reno, NV

Landscape ecologists commonly use historical information to understand current landscape patterns or to develop forecasts for future landscape change. In particular, historical range of variability (HRV) concepts have guided management decisions about responding to disturbance events or using management actions to emulate or alter natural disturbance regimes. Pinyon-juniper woodland expansion has a strong historical component, and historical information has been used to infer underlying causes and to recommend management responses. Yet how relevant is historical information in a world with rapidly changing climate and ecologically significant plant species invasions?

This paper explores the relevance of a historical context for understanding and managing pinyon-juniper woodland dynamics, including expansion into adjacent vegetation types. Underlying causes of expansion, including grazing history, fire exclusion, historical deforestation, and climate change, are explored in light of spatiotemporal patterns of recent change as derived from tree-ring studies, remote sensing analyses, and simulation modeling exercises. For one study area in the central Great Basin, historical fire regimes in woodland areas were characterized by infrequent, small, high-severity fires, although most reconstructed fires originated in narrow valley bottoms once dominated by sagebrush grassland. While it is difficult to reconstruct historical fire regimes for shrub-dominated plant community types where pinyon-juniper woodland has recently established, dynamic landscape modeling can be used to bracket the uncertainty of fire regime parameters with respect to species' life history traits and current age distribution patterns of trees. Historical patterns and reconstructed mechanisms underlying woodland expansion help to define the landscape context for contemporary management; however, management models derived from historical information must be expanded to include expected scenarios for climate change and plant species invasion. Recent loss of pinyon-juniper woodland due to drought mortality and fire, and expansion of cheatgrass into much of the burned area, suggest new foci for understanding and managing patterns of tree dominance across the Great Basin.

Peter J. Weisberg, Department of Natural Resources and Environmental Science, University of Nevada-Reno, Mail Stop 186, Reno, NV, 89557, USA, Phone: 775-784-7573, Email: pweisberg@cabnr.unr.edu

Peter Weisberg is an Associate Professor of Landscape Ecology in the Department of Natural Resources and Environmental Science at the University of Nevada, Reno. His research interests focus on broad-scale vegetation dynamics, often in a landscape restoration context, including natural disturbance regimes such as fire and floods, plant invasion ecology, and plant community response to disturbance and resource management practices. He and his research group have been studying pinyon-juniper woodland dynamics in the Great Basin for the past six years.

Riparian Ecology and Restoration in the Arid and Semiarid West: Lessons Learned

Julie Stromberg, Arizona State University, Tempe, AZ, and *Duncan Patten*, Montana State University, Bozeman, MT

The hydrology, geomorphology and biology of riparian ecosystems in the arid and semiarid West have been altered by many types of land and water uses, and many efforts are underway to restore desired ecological conditions to these systems. This presentation discusses lessons learned from rivers and springs in Arizona, California, Utah, Nevada and Montana that were subjected to restoration activities, as well as those that serve as reference ecosystems. Through case studies we demonstrate the following:

- 1) Passive vs. Active Restoration. One lesson learned is that many riparian ecosystems have high resilience. Passive restoration, or removal of stressors, can thus be an effective approach to pursue prior to taking active restoration measures. If implementing active restoration (e.g. modifying channel morphology or restoring flows), patience is required to allow for natural recruitment of riparian plants.
- 2) Stream Flow Restoration. Another lesson learned is that stream flow regimes exert key influence on riparian vegetation structure. Development of environmental flows should be river-specific and based on stakeholders' desired ecological outcomes. Adaptive management should be an integral part of the use of environmental flows allowing for adjustments when appropriate.
- 3) River/floodplain Connectivity. A third lesson is that maintaining river/floodplain connectivity is essential. By removing structures that reduce river/floodplain connectivity and/or designing environmental flows that create periodic overbank flooding, riparian floodplain processes are re-established. Re-establishment of river/floodplain connectivity may require appropriate contouring of riverine surfaces including meanders and point-bar gradients.
- 4) Riparian Plantings. Although many plant species will recolonize on their own, plantings can be useful to hasten vegetation development. Prior to planting, soil traits, stream hydrology, and other physical conditions need to be analyzed to ensure that plantings will survive.
- 5) Range of Variability. Another lesson learned is that the range of restoration targets of riparian plant communities varies greatly. The climatic and hydrologic variability that characterize dryland regions produce a range of plant communities through time. In particular, past extreme disturbance events create legacies that produce high temporal change in attributes such as vegetation abundance.
- 6) Irreversible Outcomes. Yet another lesson learned is that some environmental changes are irreversible. Withdrawal of groundwater, for example, may cause long-term changes in riparian and wetland plant communities as a consequence of long-term changes in aquifer storage.
- 7) Potential Irreversible Conditions. Finally, legal and political mandates or decisions may “trump” ecological management preventing maintenance or restoration of riparian and wetland plant communities.

Duncan Patten, Land Resources and Environmental Sciences and Big Sky Institute for Science and Natural History, Montana State University, 1605 South 5th, Bozeman, MT, 59717, USA, Phone: 406-994-2748, Email: dtpatten@montana.edu

Duncan Patten is Research Professor with the Department of Land Resources and Environmental Sciences at Montana State University and Professor Emeritus of Plant Biology at Arizona State University. Dr. Patten received the A.B. degree from Amherst College, M.S. from the University of Massachusetts at Amherst, and Ph.D. from Duke University. His research interests include arid and mountain ecosystems, especially the ecological processes of western riparian and wetland ecosystems. Dr. Patten was founding president of the Arizona Riparian Council, president of the Society of Wetland Scientists, and Business Manager of the Ecological Society of America. He is a Fellow of the AAAS, has been a member of several NAS/NRC committees, boards and commissions and is a member of EPA's Science Advisory Board.

Climate Variability, Climate Change, and Large-Scale Ecological Responses: Challenges for Ecosystem Science and Management in the West

Julio L. Betancourt, U.S. Geological Survey, Tucson, AZ

Two important sources of uncertainty in water planning and ecosystem management in the western U.S. are decadal-to-multidecadal (D2M) natural climate variability and anthropogenic climate change. D2M variability is characteristic of the instrumental record of the past century, as well as tree-ring chronologies of last two millennia. D2M variability can synchronize fluctuations in resource availability within and across regions and may play a major role in resetting ecosystems at regional scales. Although the tropical Pacific is paramount, D2M variability in the North Atlantic (the so-called Atlantic Multidecadal Oscillation or AMO) and the North Pacific (Pacific Decadal Oscillation) also may play important roles. *Resource managers have barely addressed the challenges posed by D2M variability, which makes it that much harder to reckon the impacts of climate change.* Abrupt cool season warming beginning 1976-1984, depending on the region, brought on a marked increase in springtime temperatures, an earlier onset of spring by 8 to 10 days, a rise in the elevation at which it rains rather than snows, a decrease in snowpack, earlier snowmelt timing, a shift to an earlier pulse of snowmelt-fed discharge, and an increase in the frequency of large fires. A set of nested and downscaled climatological and hydrological models was used recently to attribute many of these changes to the buildup in greenhouse gas emissions, but many questions remain. My presentation will rely on statistical approaches to identify spatiotemporal patterns of temperature, precipitation, and spring onset variations to explore their associations with various modes of large-scale climate variability in the context of climate change. *Climatic change compromises a central tenet in water and ecosystem management that natural systems fluctuate within an unchanging and well-defined envelope of variability.* These assumptions are embodied to varying degrees in the concepts of Hydrologic Stationarity (HS) and Historic Range of Variation (HRV), and most certainly in the guiding principles of restoration and preservation in environmental and natural resources law. *Adaptation to climate change will require retooling traditional methods and developing alternative ones that are better suited for managing and governing resources and ecosystems under a nonstationary climate.*

Julio L. Betancourt, U.S. Geological Survey, 1955 E. 6th St., Tucson, AZ, 85719, USA, Phone: 505-670-6821 x 107, Email: jlbetanc@usgs.gov

Julio Betancourt, a Senior Scientist with the U.S. Geological Survey, has published one book and 130 papers about the climatic effects on terrestrial ecosystems at spatial and temporal scales critical for ecological and evolutionary processes (http://www.paztcn.wr.usgs.gov/julio_cv.html). He has received awards from the American Water Resources Association, the Ecological Society of America, and the Department of the Interior. Julio was one of only two Department of the Interior scientists to receive the Presidential Rank Service Award from the White House in 2008, and was elected a Fellow of the American Geophysical Union in 2009. Julio co-founded the USA-National Phenology Network (www.usanpn.org) and is leading efforts to control buffelgrass spread in the Sonoran Desert (www.buffelgrass.org).

Adapting to Climate Change in Great Basin Mountain Ecosystems

Constance I. Millar, USDA Forest Service, Sierra Nevada Research Center, Albany, CA

Incorporating climate change, either natural variability or human-driven, into resource management forces a rethinking of basic principles and guidelines. I present a conceptual framework for adaptation strategies and illustrate this with examples relevant to Great Basin ecosystems. This framework recognizes that because conditions and capacities vary across regions, priorities and solutions will differ. A toolbox approach is most useful, where high-order management decisions range from maintaining resistance to change (establishing

refugia, habitat reclamation), promoting resilience (reducing stressors and improving health), assisting systems to move to new states (using assisted migration, relaxed germplasm transfer rules, anticipating extreme events), and realigning systems far out of natural variability (employing models tuned to the future rather than historic range of variability). Evaluating options and setting priorities will be increasingly important under uncertain future climates. At an overall level, decision-makers have three options for engaging climate-management, each defensible under different contexts. They can deliberately delay action, react after disturbance or extreme events, or act proactively in advance. Tiered methods such as no-regrets/low regrets/win-win, employing low-to high-technology approaches judiciously, and formal triage approaches are employed. Evaluating vulnerability is an essential first step. We can best learn the range of needs and tools for adaptation by engaging case-studies and sharing concrete ideas offered by field managers. The USDA Forest Service Westwide Climate Initiative conducts case studies in the Pacific Northwest, Rocky Mountain Region, and Pacific Southwest. I offer a sample of lessons learned from efforts that apply to Great Basin mountain ecosystems.

Constance I. Millar, USDA Forest Service, Sierra Nevada Research Center, 800 Buchanan St., W.A.B., Albany, CA, 94710, USA, Phone: 510-559-6435, Fax: 510-559-6441, Email: cmillar@fs.fed.us

Connie Millar has long been a leader in developing climate-adaptation tools for management of western public lands, most recently as one of four Principal Investigators of the WestWide Climate Initiative. Based at the Pacific Southwest Research Station, Dr. Millar's focus is on California and Great Basin ecosystems, but her resource-management and decision-support frameworks have applicability throughout western ecosystems. She received her Ph.D. in genetics at the University of California, Berkeley in 1984, and has been at the PSW Research Station based in the Bay Area since then. Dr. Millar leads a research team that addresses responses of subalpine forests to historic and current climates, impacts of climate change on American pika, and rock-glacier response to warming climates.

An Introduction to Paleoecological Data and Their Utility in Ecosystem Restoration

Andrea Brunelle, University of Utah, Salt Lake City, UT

Many land managers are familiar with dendrochronology and the utility of those records for ecosystem restoration. These records are valuable but are limited by the preservation of the wood on the landscape and the length of the record. While some records exceed 1000 years before present it is more common to have records less than 500 years old. Paleoecological records or reconstructions from lake or wetland sediments using pollen, charcoal and other sedimentological proxy provide a way to extend records of vegetation composition and disturbance regime further back in time, with many records covering the last 10-15,000 years and some basins going back even further. Historically there has not been much collaboration between paleoecologists and land managers. This presentation will demonstrate how and what we can learn from sedimentary records and present some results about how they are being used on the landscape for restoration and management. Comments and input on how to make these data more accessible and useful are requested.

Andrea Brunelle, University of Utah, 260 S. Campus Drive, Room 270, Salt Lake City, UT, USA, Phone: 801-585-5729, Fax: 801-581-8219, Email: andrea.brunelle@geog.utah.edu

Andrea Brunelle is an Associate Professor in the Geography Department at the University of Utah. She is a paleoecologist who uses lake and wetland sediments to study past environments with a focus on disturbance and issues related to land management. She is currently working in the borderlands region of the United States and Mexico, the high plateaus of Utah, and the Northern Rocky Mountains of Idaho and Montana (among other places). Andrea has her bachelors of science in Environmental Geology and a masters of science in Paleoecology/Quaternary Studies from Northern Arizona University in Flagstaff, AZ. She completed her Ph.D. in Geography at the University of Oregon in Eugene.

Historic Fire Regimes as Templates for Fire Restoration in Eastern Great Basin Mountains, or: Eating the Elephant a Bite at a Time

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

Fire and vegetation histories can provide useful templates for restoration of functional fire/forest systems. Multi-century (300-800 yr) fire histories were recently developed from tree rings for 10 sites located on six eastern Great Basin ranges. Vegetation (tree) histories were developed for four sites. These histories reveal fire regimes dominated by low and mixed severity fire with highest fire frequencies in mid-elevation (2,300-2,700 m) ponderosa pine and dry mixed-conifer forests. Within this general pattern, topography dictated conditions of low (fire protected) and high (high severity) fire risk. Most fires were relatively small. Fire seasonality was bimodal, with early and late-season fires dominant. This pattern differs from the mid-season peak of modern lightning-caused fires suggesting the probability of a significant role of human ignitions in historic fire regimes. After fire regime change during the mid to late 1800s, tree density increased on forested locations and trees encroached into mountain shrub-grass steppe. This steppe type is located roughly parallel to ponderosa pine and dry mixed-conifer stands on dry, mid-elevation aspects and provided a partial fuel buffer between pinyon-juniper below and mixed-conifer, subalpine and aspen stands above. Strategies to restore fire should focus first on mid-elevation stands of mixed-conifer forest and degraded (tree-invaded) steppe that have experienced the most change in fire regime and vegetation/fuel structure. Early and late-season prescribed fire should be integrated with mechanical treatments and native plant seedings as necessary to accomplish fuel modification and restoration goals. Frequent small fires that mimic historic processes will aid in fostering public acceptance of fire as a tool. Well-planned implementation of prescribed fire will reduce the risk of catastrophic fire and, over time, promote landscape heterogeneity consistent with multiple resource objectives.

Stan Kitchen, USDA Forest Service, Rocky Mountain Research Station, Shrub Sciences Laboratory, 735 North 500 East Provo, UT, 84606, USA. Phone: 801-356-5109, Fax: 801-375-6968, Email: skitchen@fs.fed.us

Stanley Kitchen has worked in various positions over the past 21 years at the Rocky Mountain Research Station, Shrub Sciences Lab in Provo, UT. Current duties include scientist-in-charge and manager of the Desert and Great Basin Experimental Ranges. Research interests include: historic fire regimes and drivers, post-fire succession of forests and shrublands, and cold-desert ecology. Most of his work has focused on ecosystems of the Great Basin region of the Western U.S..

Pricing the Priceless: Valuing Nonmarket Goods and Ecosystem Services

Patty Champ, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

One of the most basic ideas in economics is that of tradeoffs. Thinking about the tradeoffs associated with a project or program is straightforward when costs and benefits are observed in a market setting. When Walmart increases the size of a parking lot, they can observe how that change affects sales. However, measuring benefits and costs can be tricky when the benefits are not associated with a revenue stream or when the costs fall on future generations. Land managers often operate in such settings. What if someone is charged with the utilitarian concept of managing the land for “the greatest good for the greatest number?” Or worse yet, the Pinchot idea of managing the land for “the greatest good for the greatest number in the long run?” In this presentation, I describe both why and how economists measure benefits and costs that fall outside of structured markets. I make a case for understanding nonmarket values and valuing ecosystem services in the effort to sustain the Great Basin landscapes.

Patty Champ, USDA Forest Service, Rocky Mountain Research Station, 2150-A Centre Ave, Fort Collins, CO, 80526, USA, Phone: 970-295-5967, Email: pchamp@fs.fed.us

Patty Champ has been with the Rocky Mountain Research Station in Fort Collins, CO for the past fifteen years. Her main area of research has been nonmarket valuation. She edited a Primer on Nonmarket Valuation with Kevin Boyle and Tom Brown in 2003. She has applied nonmarket valuation techniques to look at the impact of wildfire risk on home sales prices, the health impacts of exposure to wildfire smoke, wind generated electricity, re-introducing whooping cranes and many other environmental/natural resource issues. Prior to joining the Rocky Mountain Research Station, Patty received her Ph.D. in Agricultural and Applied Economics from the University of Wisconsin.

Sage-grouse and Fire: Smokey the Bear Was a Good Guy

J. W. Connelly, Idaho Department of Fish and Game, Department of Biological Sciences, Idaho State University, Pocatello, ID

The Greater Sage-grouse (*Centrocercus urophasianus*) is a sagebrush (*Artemisia spp.*) obligate that now occupies only 56% of its likely distribution prior to European settlement. Range-wide, populations have been declining at an average of 2.0% per year from 1965 to 2003. Concerns about declining sage-grouse populations coupled with information on habitat loss have prompted multiple petitions to list the species under the Endangered Species Act. Available evidence clearly supports the conclusion that conserving large landscapes with suitable habitat is important for conservation of sage-grouse and other sagebrush obligate species. Invasive plant species, wildfires, weather, and climate are major influences on sagebrush habitats and present a significant challenge to long-term conservation of sagebrush systems. Numbers of fires and total area burned have increased since 1980 throughout most sagebrush-dominated habitats. Recent research suggests that fires were much less frequent in sagebrush-dominated landscapes, especially in more xeric areas, than previously believed. The continued interest in prescribed burning and other forms of sagebrush reduction in sagebrush-dominated landscapes, despite a large body of evidence documenting the negative effects of these actions on sage-grouse, may continue to degrade and fragment sage-grouse habitats.

Jack Connelly, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID, 83204, USA, Phone: 208-282-5422, Email: jcsagegrouse@aol.com

Jack Connelly is a Principal Wildlife Research Biologist with the Idaho Department of Fish and Game. Jack received his B.S. degree from the University of Idaho and his M.S. and Ph.D. degrees from Washington State University. He is the lead author of the Sage-grouse Management Guidelines and the Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats. Jack has been involved in research and management of sage-grouse and sagebrush habitats in the Intermountain West for 33 years.

Fire Ecology of Sagebrush Systems: To Burn or Not to Burn for Wildlife Habitat

Carl L. Wambolt, Department of Animal and Range Sciences, Montana State University, Bozeman, MT

There are nearly 200 mammals and birds that have at least some dependence on sagebrush in their natural habitats. These wildlife species may rely on sagebrush taxa for forage, security cover, thermal cover, or nesting-fawning-calving cover. It is intuitive that sagebrush habitats did not burn frequently under natural conditions. Sagebrush taxa do not generally possess characteristics that allow them to endure fire. Because sagebrush taxa are the climatic dominants over nearly all their range, it is logical that they did not cope with fire as often as many other vegetative types. In the same manner, fauna of the sagebrush types evolved with niches created by

sagebrush taxa and subdominant plant species. Manipulation of sagebrush systems by fire or other means often does not produce the theorized benefits, but can be expected to result in loss of native fauna.

Carl Wambolt, Emeritus Professor, Department of Animal and Range Sciences, Montana State University, PO Box 172900, Bozeman, MT, 59717-2900, USA.

Carl Wambolt is a range ecologist with 40 years experience at Montana State University as an educator, researcher, and extension specialist. His major research emphases have been ecological investigations of plants and animals in communities dominated by sagebrush and associated taxa. This research has involved a variety of topics among which herbivory of wild ungulates, fire relationships and successional patterns of communities are dominant. This research has resulted in over 300 published scientific papers and abstracts, outreach articles, and graduate theses.

Ecology and Management of Invasive Species

Dean E. Pearson, USDA Forest Service, Rocky Mountain Research Station, Missoula, MT, and Yvette K. Ortega, USDA Forest Service, Rocky Mountain Research Station, Missoula, MT

Biological invasions present unique natural resource management challenges. When exotic species invade native systems, they shift the system out of its natural equilibrium dynamic and launch it onto a new trajectory defined by the invader's impacts – the invasion trajectory. Understanding biological invasions in light of the invasion trajectory is crucial to effective invasive species management. Although management practices such as chemical and biological control offer powerful tools that can alter the invasion trajectory, they rarely extirpate the invasive species and return the system to its historic state. Moreover, much like in human medicine, management tools can have potentially negative side effects that can exacerbate the problem. Thus, effective invasive species management requires understanding the invasion trajectory and how management tools alter the trajectory so we can ensure that management actions improve system conditions. Here, we present a heuristic model for understanding, studying, and managing biological invasions in this light. We provide examples from an ongoing research program on spotted knapweed to illustrate the importance of determining the invasion trajectory in order to predict the community-level impacts of the invader over time and provide a baseline for evaluating the efficacy of management actions. We discuss how applying this approach can provide managers with the necessary knowledge to make informed decisions that will maximize efficacy and minimize side effects of management actions.

Dean Pearson, USDA Forest Service, Rocky Mountain Research Station, 800 E. Beckwith Ave, Missoula, MT, 59801, USA, Phone: 406-542-4159, Fax: 406-543-2663, dpearson@fs.fed.us

Dr. Dean Pearson received his B.S. in Wildlife Biology (1992), his masters in Zoology (1995), and his Ph.D. in organismal biology and ecology (2005) from the University of Montana. He is a research ecologist with the USDA Forest Service, Rocky Mountain Research Station, where he has worked for the past 14 years. He is the team leader for the RMRS Invasive Species Working Group and the Wildlife Ecology Unit's Invasive Species Research Team.

Wildfire and Fuel Treatments in Riparian Areas of the Interior West

Kathleen Dwire, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

Riparian areas frequently differ from adjacent uplands in vegetative composition and structure, hydrology, microclimate, and fuel characteristics. These features may contribute to different fire environments, behavior,

and properties, which also depend on elevation and regional and watershed physical factors. However, until recently only a few studies had investigated the behavior, properties, and influence of wildfire on western riparian areas. Recently, research attention has focused on the impacts of fire on aquatic and riparian ecosystems, on fire behavior and effects along stream channels, and the role of fuel reduction treatments as riparian restoration projects. Current issues and recent findings on wildfire and riparian ecosystems will be summarized, and case studies of riparian fuel treatments will be presented.

Kathleen Dwire, Research Riparian Ecologist, USDA Forest Service, Rocky Mountain Research Station, 240 West Prospect, Fort Collins, CO, 80526-2098, USA, Phone: 970-498-1016, Fax: 970-498-1010, Email: kadwire@fs.fed.us

Kate Dwire is a research riparian ecologist with the USDA Forest Service, Rocky Mountain Research Station in Fort Collins, CO and affiliate faculty at Colorado State University and the University of Wyoming. Research interests include: 1) the influence of prescribed and natural fire on riparian areas, 2) the distribution of wetland and riparian plant species in relation to physical variables and disturbance (natural and anthropogenic), and 3) instream large wood recruitment processes.

Perspectives on Future Directions for Management and Restoration in the West

Ron Ryel, Utah State University, Logan, UT

This conference has highlighted the breadth of perspectives on management and restoration of western landscapes. It has also highlighted some of the controversies, limits in perspective, the need for better understanding on a range of issues, and the importance of integrated efforts in obtaining desired outcomes. In this presentation, a summary of issues is presented in the context of a broad framework that attempts to link across the breadth of issues and disciplines. The importance of integrating ideas and approaches, and perhaps the need for developing new paradigms, is discussed.

Ron Ryel, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT, 84322-5230, USA, Phone: 435-797-8119, Fax: 435-797-3796, Email: ron.ryel@usu.edu

Ron Ryel is an associate professor in the Department of Wildland Resources at Utah State University. Trained as a plant physiological ecologist, his research interests focus on how plants, through physiology and structure, affect ecosystem function. His work has often been conducted in shrub-steppe and western aspen systems. He sees effectively linking science to management as a priority for managing landscapes and to that end was involved in forming the Restoring the West conference series here at USU, and the Western Aspen Alliance.

Poster Abstracts

Alphabetically,
presenting author in italics

Effects of Climate Change and Nitrogen Deposition on *Bromus tectorum* L. Invasion in the Eastern Sierra Nevada, CA

Amy L. Concilio and Michael E. Loik, University of California-Santa Cruz, Santa Cruz, CA

Bromus tectorum L., has displaced native shrub and bunchgrass communities throughout the Great Basin Desert. At higher elevations in the eastern Sierra Nevada, *B. tectorum* invasion has been slow and appears to be limited by temperature and a shorter growing season due to the deep winter snowpack. However, changing climatic patterns and edaphic conditions may facilitate increased invasion. Invasibility is likely to vary spatially by land use, disturbance history, and microhabitat. Our research objectives were to: 1) determine how *B. tectorum* will respond to the coupled effect of changing snowfall and increased nitrogen deposition, 2) identify differences across microhabitats (i.e., under the shrubs *Artemisia tridentata* and *Purshia tridentata*, and in intershrub spaces), and 3) identify differences due to disturbance history (grazing (GU), burning (UB), and their combination (GB)). To determine effect of precipitation changes, we used snow fences that created zones of increased and decreased snowpack. Paired plots were established within each snow treatment in the three microhabitats to simulate increased and ambient levels of N deposition. Impacts of N effects on invasibility were measured in three sites with different disturbance histories.

Bromus tectorum growth and fecundity were measured throughout the 2008 growing season, as was native species composition and abundance. During the first year of treatment application, there were no apparent changes in species diversity or composition by snowpack or N treatment, though there was an effect of disturbance history. Species richness was greater in GU and UB than in GB plots. Correspondingly, *B. tectorum* was twice as common at the grazed-burned site than with grazing or burning alone. The number of *B. tectorum* spikelets per individual appeared to increase with both increased and decreased snowpack compared to ambient conditions (though the difference was not significant), while the density decreased. This resulted in similar propagule pressure across all snow treatments. *B. tectorum* response to N appears to be affected by microhabitat and disturbance history. These results suggest that *B. tectorum* may become more competitive under certain climatic and edaphic conditions, though responses will likely vary spatially across the landscape with disturbance history and microhabitat. The interaction of multiple agents of global change is likely to have much more complex effects than any single driver alone.

Amy Concilio, Department of Environmental Studies, University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA, 95060, USA, Phone: 831-295-4359, Email: aconcili@ucsc.edu

Associations of Near-surface Soil Moisture and Annual Plant Community Dynamics

Ronald J. Ryel¹, *Lauren Ducas*¹, A. Joshua Leffler², and Scott B. Jones¹

¹Utah State University, Logan, UT

²Forage and Range Research Laboratory, USDA-ARS, Logan, UT

Vast areas of sagebrush-steppe are characterized by the loss of species or functional diversity related to species invasions. When the process of community disassembly is advanced, changes in water resource pool dynamics can provide a resource for establishment of other species populations. Cheatgrass is an invasive annual that has become dominant in extensive areas previously occupied by big sagebrush-steppe communities. In years when near monocultures of cheatgrass experience fall mortality post-germination, soil moisture pools in the top 50 cm

are not completely used and the system is more likely to be invaded, particularly by other annuals. The objective of this study was to assess whether more complete utilization of upper soil moisture by cheatgrass acts to reduce the potential for new invaders. Soil moisture was measured in a near-monoculture cheatgrass stand during two periods, 2000-2002 and 2007-2009, when fall mortality of cheatgrass was followed by rapid community change to annual forbs. Measurements and soil water modeling were used to generate a continuous set of volumetric water contents for both periods. Species composition at the site was also recorded. Between the period 2000-2002 and 2007-2009, the cheatgrass dominated system rapidly changed to an annual forb dominated community following years when fall mortality of seedling cheatgrass occurred. When cheatgrass did not experience early mortality (2000, 2002) and dominated ground cover, the water content remaining in the upper soil pool at mid-summer as a percentage of the water content at the start of the spring growing season was 57.9% in 2000 and 42.6% in 2002 for the 30 cm layer and 70.5% (2000) and 70.1% (2002) for the 45 cm layer. When cheatgrass experiences fall mortality (late 2000 and 2007), these ratios the following summer are 88.6% (2001) and 84.5% (2008) for the 30 cm layer and 114.5% (2001) to 101.7% (2008) for the 45 cm layer. While the annual forbs dominated for only one year, our results show the importance of the interplay between available soil moisture, and rapid community change and invasion potential. This rapid community change also has the potential to be used as a restoration tool -- available resources from post-germination cheatgrass mortality may be used for the establishment of native species in restoration areas.

Lauren Ducas, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT, 84322-5230, USA, Phone: 435-720-0803, Fax: 435-797-3796, Email: lauren.ducas@aggiemail.usu.edu

Using Remote Sensing to Understand Spatiotemporal Landscape Dynamics of Aspen Decline in Southern Utah

*Dave Evans*¹, Ron Ryel¹, Doug Ramsey¹, Dale Bartos², and Chad Oukrop¹

¹Utah State University, Logan, UT

²USDA Forest Service, Rocky Mountain Research Station, Logan, UT

Extensive mortality of quaking aspen (*Populus tremuloides Michx.*) has been observed around southern Utah's Cedar Mountain over the past decade, inciting concern among land owners and natural resource managers alike. This decline has increased during the opening decade of the 21st Century and may be correlated with drought. This study attempted to clarify various spatiotemporal aspects of the aspen decline through remote sensing. The main objective was to determine the extent of aspen coverage on the Cedar Mountain area in 1985 and to document how aspen coverage has changed over time. To accomplish this, binary models of aspen presence-absence were created for the years 1985, 1990, 1995, 2001, 2003, 2005, and 2008 using classification and regression tree (CART) modeling. The six reflective bands of the Landsat Thematic Mapper and various topographic variables derived from digital elevation models were used as predictor variables. A post-classification comparison technique was used to spatially detect change between consecutive time periods. Results of the change detection showed significant aspen decline occurring between 1985 and 1990, 1990 and 1995, and 2001 and 2003. This step-wise pattern of decline correlated to years of drought during the time frame, especially in reference to winter snow pack. Preliminary analysis of snow water equivalencies suggest that aspen die-off occurred during the summer following two consecutively dry winters. Preliminary evidence also suggests that droughty summer conditions during the early 1990's contributed to the decrease in aspen cover during this time period.

Dave Evans, Utah State University, 5200 Old Main Hill, Logan, UT, 84321, USA, Phone: 435-797-4482, Email: dave.evans@aggiemail.usu.edu

The Great Basin Research and Management Partnership

Jeanne Chambers, U.S. Forest Service Rocky Mountain Research Station, Reno, NV, Stuart Hardagree, USDA Agricultural Research Service, Northwest Watershed Research Center, Boise, ID, Linda Schueck, Thomas Zarriello, and *Sean Finn*, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Boise, ID

The Great Basin is considered to be one of the most endangered ecoregions in the United States. The human population is expanding at the highest rate in the nation, and major sociological and ecological changes are occurring across the region. These changes can be attributed to numerous interacting factors including urbanization, changing technology and land use, climate change, limited water resources, altered fire regimes, invasive species, insects, and disease. Managers across the Great Basin are increasingly challenged to maintain or improve the ecological condition of these systems and the services that they provide while meeting the needs of a growing number of user groups with diverse and often opposing interests. Sustaining the ecosystems, resources and human populations of the Great Basin will require strong collaborative partnerships among research and management organizations in the region. The Great Basin Research and Management Partnership (GBRMP; <http://greatbasin.wr.usgs.gov/gbrmp/>) is meeting this challenge by promoting comprehensive and complementary research and management collaborations to sustain ecosystems, resources and communities across the Great Basin. GBRMP's fully vetted Memorandum of Understanding has been signed by 6 federal agencies, 2 state agencies, and 6 academic institutions and is an open invitation to additional members who share our vision. That vision is to foster development of teams representing the full spectrum of organizations and stakeholders that work together to solve the region's ecological and socio-economic issues through the integration of research and management. GBRMP does not replace existing collaborations, but builds upon their strengths by increasing coordination and communication among them. GBRMP provides a mechanism for assembling the diverse research and management groups working in the Great Basin to: 1) obtain consensus in identifying and prioritizing regional issues, 2) expand and help focus existing collaborative efforts, and 3) facilitate new teams to address emerging issues.

It also provides critical information sharing capacity for both existing collaborations and new teams. GBRMP is working to develop tools and resources to achieve these objectives. Two of these tools, the Collaborations Database and the Experts Database, are fully searchable, interactive web resources designed to bring existing teams and subject matter experts together to tackle common problems and use limited resources efficiently. These databases and other GBRMP tools will be available for demonstration at the conference.

Sean Finn, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, Boise, ID, 83706 USA, Phone: 208-426-2697, Email: sfinn@usgs.gov

SAGEMAP: A GIS Database for Sagebrush Habitats and Shrubland Wildlife Management in the Intermountain West

Thomas Zarriello, Linda Schueck, and *Sean P. Finn*, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, Boise, ID

Sagebrush and shrubsteppe ecosystems cover a substantial portion of mid and low elevations of western North America and harbor a unique assemblage of plants and animals. Because these ecosystems are present over a large landscape, encompassing parts of 13 U.S. states and 3 Canadian provinces, and this landscape is dissected by a tremendous variety of private ownership and public management, grasping a true understanding of the species and resources present and the role of natural and anthropogenic disturbances that shape the biome is an all but impossible task. One problem facing shrubland researchers and managers was the lack of a centralized repository for spatial data that could be relied on to deliver all current, relevant data. Thus, an ecologist using

a GIS to study some aspect of shrubsteppe ecology would need to spend valuable time and resources tracking down data from disparate sources or by ‘reinventing the wheel’ – creating data that already existed but was difficult to obtain. We developed the SAGEMAP web portal to address this issue. SAGEMAP contains almost 4000 GIS data layers and associated metadata describing nearly every aspect of shrubsteppe and sagebrush ecosystems, from climate to soils, landcover, plant and animal distributions, natural disturbances, industrial development, and ecological models. The datasets can easily be queried by spatial location and/or data theme and in most cases can be downloaded in a matter of minutes. The GIS data on SAGEMAP has a positive feedback response in that spatial data produced by analysis gathered from SAGEMAP could then be available on the website for others to view and analyze. In addition, SAGEMAP provides a schedule of upcoming meetings, symposia, and workshops that address sagebrush and sage-grouse research and management issues, as well as an updatable forum describing progress on the various projects being conducted by the U.S. Geological Survey Snake River Field Station (which hosts SAGEMAP) and their collaborators. Since its roll-out in late 2001, SAGEMAP has been visited by internet users over 2.6 million times, and more than 13 terabytes of data have been transferred to users. Visit SAGEMAP at: <http://sagemap.wr.U.S. Geological Survey.gov>.

Sean P. Finn, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, Boise, ID, 83706, USA, Phone: 208-426-2697, Email: sfinn@U.S. Geological Survey.gov

The Great Basin Information Project: Providing Consolidated and Efficient Access to Information about the Great Basin and Columbia Plateau

Sean P. Finn, Linda Schueck, and Thomas J. Zarriello, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, Boise, ID

The Great Basin Information Project (GBIP) is the high-desert front piece of the National Biological Information Infrastructure, an electronic information network providing access to biological information about our nation’s plants, animals, and ecosystems. GBIP (<http://greatbasin.nbii.gov>) focuses on the unique and changing ecosystems of the Great Basin and Columbia Plateau in the western U.S. Many of the changes in these regions, including urbanization, altered fire patterns, loss of sagebrush, and invasion of non-native plants are tied to local or individual decisions in the absence of a cumulative understanding of the consequences. As a critical step toward cumulative understanding, GBIP provides many unique information products including:

- 1) A metadata server that identifies and documents spatial and tabular data relevant to managers and researchers in the sagebrush biome. Metadata records are fully searchable and each provides a link to access the data itself
- 2) The Great Basin Bibliography, which includes over 3,700 papers from scientific journals, theses and dissertations, government publications, and popular magazines and newspapers
- 3) An educational internet mapper which provides visualization of the geology, water, vegetation, and human element in the Great Basin and allows customized map generation
- 4) The Science Locator which uses ArcIMS technology to deliver information about the researchers and managers themselves. Conceptually, the Science Locator allows users to quickly elucidate the location, subject matter, progress, and key players of any research or management project occurring in the western U.S.
- 5) The SAGEMAP spatial data portal (<http://sagemap.wr.U.S. Geological Survey.gov>) which provides access to over 3,000 GIS data layers in the sagebrush region through three optional search mechanisms.

Sean P. Finn, U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Snake River Field Station, Boise, ID, 83706, USA, Phone: 208-426-2697, Email: sfinn@U.S. Geological Survey.gov

The ARS Area-wide Ecologically Based Invasive Plant Management (EBIPM) Project: Science-based Solutions for Invasive Annual Grasses

Stuart P. Hardegree, USDA Agricultural Research Service, Boise, ID, Roger L. Sheley, Brenda S. Smith, and Edward A. Vasquez, USDA Agricultural Research Service, Burns, OR

The Area-wide EBIPM project is a large, collaborative effort funded by USDA-ARS to bring together state and federal land managers, researchers, ranchers, and policy makers to develop and implement ecologically-based invasive plant management to guide successful restoration efforts where invasive plants dominate the ecosystem. The EBIPM framework is a comprehensive decision tool that integrates ecosystem health assessment, and knowledge of ecological processes and principles to formulate initial restoration strategies and to adjust those strategies as management progresses (i.e. adaptive management). Expected outcomes from this project are increased rangeland health and resource values, lower fire-fighting costs, and enhanced environmental quality. To catalyze the implementation of EBIPM, landscape scale demonstrations and small plot research projects are being conducted at multiple sites across the Great Basin. Economic analysis of the benefits and costs of invasive grass infestations and EBIPM implementation strategies are also being conducted. Education and technology transfer are central to implementing a long-term, self-sustaining program where EBIPM is adopted on a large scale. The goal for the education program is to give land managers the skills, ideas, and practical knowledge to implement EBIPM and to establish and maintain healthy rangelands into the future. A number of decision support tools have been created, and workshops, field days, and training opportunities are scheduled for 2010. Further information can be found at www.ebipm.org.

Stuart P. Hardegree, USDA-ARS-Northwest Watershed Research Center, 800 Park Blvd., Suite 105, Boise, ID, 83712, USA, Phone: 208-422-0728, Fax 208-334-1502, Email: stuart.hardegree@ars.usda.gov

Response of Bee Pollinators to Wildfire in Sagebrush Steppe

Jim Cane, USDA Bee Biology and Systematics Lab, Logan, UT, and *Byron Love*, Bee Biology & Systematics Lab, Utah State University, Logan, UT

The agricultural production of seeds, as part of the Great Basin Restoration Initiative, has been accelerated in an effort to reintroduce native forb communities in degraded rangelands. Native seed production and the process of reseeding are expensive endeavors. The success of post-fire forb revegetation depends in part on the presence of pollinators. Understanding how bees respond to fire is therefore an important objective in restoration efforts. Our research indicates that ground nesting bees can endure low, moderate, and in some cases high fire-intensity, and above-ground nesting bees are quick to recolonize burned areas. The presence of bees is not limited by fire intensity or area. However, pre-fire habitat structure does influence bee diversity. Degraded habitat low in forb diversity is similarly low in bee diversity. Whether bee diversity in reseeded patches can exceed the diversity of surrounding degraded habitat is the subject of future research.

Byron Love, Bee Biology & Systematics Lab, Utah State University, 5310 Old Main Hill, Logan, UT, 84322-5310, USA, Phone: 916-893-5532, Email: blove@biology.usu.edu

Plowing Up the Past: Land Use Legacies of Dry Farming in the Great Basin

Lesley R. Morris and Thomas A. Monaco, USDA-ARS Forage and Range Research Laboratory, Logan, UT

A century has passed since the Enlarged Homestead Act helped fuel a dry-farming land boom across the western U.S. Over 18 million acres of land were entered for patent in the first year after its passage, the highest annual

acreage in the history of homesteading. Unfortunately, when dry-farming homesteads failed, the history of these plowed under arid lands was ignored and forgotten. Therefore, the land use legacy from cultivation in sagebrush ecosystems of the Great Basin remains largely unexamined even though there is an estimated 3 million acres of cultivated and abandoned rangeland in the Intermountain West. We compared vegetation and ground cover of dry-farm fields and adjacent unplowed sagebrush ecosystems to determine recovery status approximately 90 years after cultivation. Our study included six of these paired sites across three different ecological sites in Park Valley, Utah. Cultivated areas had lower shrub and forb cover, higher cover of grasses (typically *Elymus elymoides*), higher ground surface rock cover, and lower biological crust cover. Additionally, the composition of shrub species for one paired site had been completely altered. These results demonstrate that dry farming has long-lasting impacts on plant community pathways and key ecosystem properties. Our speculation is that the historical disturbance of dry farming has important implications for land management activities and ecological site classification.

Lesley R. Morris, USDA-ARS Forage and Range Research Laboratory, Utah State University, 690 North 1100 East, Logan, UT, 84322-6300, USA, Phone: 435-512-2248, Email: lesleyrmmorris@gmail.com

Sagebrush Steppe Treatment Evaluation Project: A Long-Term Monitoring and Ecological Network

James McIver, Oregon State University Eastern Oregon Agricultural Research Center, Union, OR, **Summer Olsen**, Utah State University, Logan, UT, and **Nora Devoe**, Bureau of Land Management, Reno, NV

Healthy sagebrush steppe communities in the Great Basin are rapidly disappearing due to invasion of non-native plants (especially cheatgrass), catastrophic wildfires, and encroachment of pinyon-juniper woodlands. The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) is a long-term study to evaluate methods of sagebrush rangeland restoration. Experimental sites have been established across the Great Basin to evaluate effects of land management options including prescribed fire, mechanical thinning of shrubs and trees, and herbicide application, that can reduce the potential for wildfire and restore healthy and diverse native plant communities. The project is fully interdisciplinary with ecological, economic, and social components. Results of this project provide resource managers with information to reduce the risk and uncertainty of restoration decisions. Initial support for SageSTEP came from the Joint Fire Science Program (JFSP) for a 5-year study that began in 2005. As this initial phase of the project comes to an end, we are looking toward the future and the benefits of continued monitoring of the study plots. This poster gives a basic overview of the study and outlines the features of long-term monitoring of the study sites, as well as its relevance to climate change issues.

Summer Olsen, Department of Environment and Society, Utah State University, 5215 Old Main Hill, Logan, UT, 84321, USA, Phone: 435-797-8455, Fax: 435-797-4048

A Remote Sensing Landscape Analysis of Sudden Aspen Decline (SAD) in Southern Utah's Cedar Mountain

Chad M. Oukrop¹, Ron Ryel¹, Dale Bartos², Doug Ramsey¹, and Dave Evans¹

¹Utah State University, Logan, UT

²USDA Forest Service, Rocky Mountain Research Station, Logan, UT

Quaking aspen (*Populus tremuloides* Michx.) is the most widespread deciduous tree species in North America. In the Intermountain West, aspen communities are highly valued multiple use ecosystems, noted for forage production, understory diversity, wildlife habitat, timber, and aesthetics. However, aspen communities in the Intermountain Region of the western United States are in evident decline, with certain areas experiencing

Sudden Aspen Decline (SAD) over the past decade, a phenomenon defined by rapid overstory mortality with little or no regeneration. Recently, landowners on Cedar Mountain in southern Utah have expressed concern over the occurrence of SAD across portions of the mountain and surrounding area. Land managers lack critical information on the extent and magnitude of SAD and could utilize detailed spatial information to plan, implement, and monitor aspen restoration projects. The main objectives of this study was to produce a map of the 2008 aspen health status and to examine bio/physical parameters (i.e. slope, aspect, elevation) related to SAD across the Cedar Mountain landscape.

A supervised classification composed of 3 aspen health stages (1=healthy, 2=damaged, 3=seral) was produced using Classification and Regression Tree (CART) analysis. An accuracy assessment using 445 points was conducted using 2006 National Agriculture Imagery Program (NAIP) digital ortho photography. The classification estimated 34% of the Cedar Mountain landscape to be affected by SAD with an overall map accuracy of 81.3%. For the Cedar Mountain study area, damaged stands (SAD) were found primarily at lower elevations on south-to-west aspects. Within the elevation range of most aspen, the mean elevation of damaged stands (2,708 m) was lower than that of the mean elevation of healthy aspen stands (2,754 m). Aspect (moisture index) was also found to be significant, with damaged stands primarily on southerly aspects and healthy stands generally on northerly aspects. Slope did not appear to be a driving factor in the analysis. These results support the hypothesis that moisture limitations (i.e. recent drought and unseasonably high temperatures) may be directly related to the SAD areas for the Cedar Mountain region.

Chad Oukrop, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT, 84322-5230, Phone: 701-367-5361, Email: c_oukrop@yahoo.com

Colorado Plateau Native Plant Initiative

Wayne Padgett, Bureau of Land Management, Salt Lake City, UT

The Colorado Plateau Native Plant Initiative (CPNPI) was established as a part of the Seeds of Success Program. The Seeds of Success protocol includes six steps: 1) native seed collection, 2) evaluation and development, 3) field establishment, 4) seed production by private growers, 5) seed storage, and 6) restoration of native plant communities. The CPNPI will concentrate on following Steps 1-5 of this strategy in order to increase the availability of native plant materials for agencies and private individuals and organizations interested in restoring native plant communities occurring in the Colorado Plateau Ecoregion (Step 6).

The vision, goals, and objectives for the CPNPI have been defined and incorporated into a 5-year strategy and action plan. Target species have been identified for research and development, and field testing has begun on several species by partners of the CPNPI – the Uncompahgre Plateau Project and the U.S. Forest Service. Participation in, and coordination with, the CPNPI is voluntary, but cooperators will benefit from sharing information and coordinating efforts in order to increase efficiencies and limit the potential for duplicating efforts.

Wayne Padgett, Utah State Office, Bureau of Land Management, PO Box 45155, Salt Lake City, UT, 84145-0155, USA, Phone: 801-539-4076, Fax: 801-539-4074, Email: wayne_padgett@blm.gov

Land Treatment Digital Library: A Dynamic System to Enter, Store, Retrieve, and Analyze Federal Land-treatment Data

David S. Pilliod and Justin Welty, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

The Land Treatment Digital Library (LTDL) was created by the U.S. Geological Survey to catalog information about land treatments on federal lands in the western U.S. Land treatments include activities such as removal or alteration of plant biomass, seeding burned areas, and herbicide applications. The LTDL currently houses more than 6000 land treatments across 15 Bureau of Land Management (BLM) field offices, including more than 1000 aerial seeding treatments and over 700 drill seeding treatments. Land treatment data from all 106 western BLM field offices will be entered and verified over the next 5 years. The LTDL can be used to respond to information requests, conduct analyses and other forms of information syntheses, produce maps, and generate reports for Department of the Interior managers and scientists and other authorized users

David S. Pilliod, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, 970 Lusk St., Boise, ID, 83706, USA, Phone: (208) 426-5202, Email: dpilliod@U.S. Geological Survey.gov

How Will Climate Change Affect Significant Rangeland Forbs?

Hilary Whitcomb, Mark Brunson, and Eugene Schupp, Utah State University, Logan, UT

Little is known about how climate change will affect western rangelands. Most current research focuses on predicting effects on grasslands, or rates of conversion from grassland to shrub- or woodland. Without such information, managers are left to make educated guesses that may or may not match actual outcomes. Accordingly we are studying potential effects of growing-season temperature rise with the following research objectives: 1) to examine the effects of increased temperature on two indigenous forbs that are important to sage grouse and Native Americans and compare to the same results for two invasive forbs that could displace native forbs and disrupt community structure and ecology, and 2) to evaluate rangeland manager perspectives on climate change and of the forb community in sage steppe ecosystems. Temperature effects were determined using a factorial design with four species crossed with two temperature treatments (control vs. elevated) resulting in eight treatment combinations. Each treatment was replicated ten times. To increase temperature in the field, passive warming open-top-chambers (OTC) constructed from Sun-LiteHP (0.10cm thick) fiberglass for solar applications were set up. The focus plants are: *Sphaeralcea munroana* (Munro's Globemallow), *Crepis acuminata* (Tapertip Hawksbeard), *Erodium cicutarium* (Storksbill) and *Lactuca serriola* (Prickly Lettuce). Managers' perspectives will be determined through semi-structured interviews of rangeland managers in the Great Basin. The information gathered will be used to predict implications of experimental results and provide baseline information for potential future studies. Future studies will focus on temperature effects on forb community dynamics.

Hilary L. Whitcomb, Department of Environment and Society, Utah State University, 5215 Old Main Hill Logan, UT, 84322-5215, USA, Phone: 415-317-4642, Email: hilarylouise@gmail.com

Effects of Sagebrush Restoration Treatments on Pygmy Rabbit Space Use

Tammy L. Wilson, Utah State University, Logan, UT, and Thomas C. Edwards Jr., U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit, Logan, UT

The effects of widespread sagebrush restoration treatments on pygmy rabbits (*Brachylagus idahoensis*) are not well understood. Pygmy rabbits are among some sagebrush-obligate species for which sagebrush removal treatments of any size or type may be detrimental. We evaluated the effects of experimental sagebrush removal on pygmy rabbit second and third order habitat selection using Monte Carlo simulation from null models. We show no evidence that treatments affect second order selection, and that pygmy rabbits are not extirpated from pastures containing habitat treatments. We found evidence of third order selection only from two rabbits with centers of activity very close to the treatments. We also used snow tracking to show that pygmy rabbits entered treatments less often than expected by chance. If treatments cannot be avoided in areas with pygmy rabbits, then the treated patches should be small and well connected to prevent potentially limiting movement of rabbits amongst the untreated habitat.

Tammy L. Wilson, Department of Wildland Resources, Utah State University, 5230 Old Main Hill, Logan, UT, 84322-5230, USA, Phone: 435-797-3892, Email: t.w@aggiemail.usu.edu

Tools for Landscape Management: Northwest Utah Landscape Modeling

Elaine York¹, Louis Provencher², Gen Green¹, and Leonardo Frid³

¹The Nature Conservancy, Salt Lake City, UT

²The Nature Conservancy, Reno, NV

³ESSA Technologies, Vancouver, BC

Stakeholders from the Utah Partners for Conservation and Development used partner data, predictive computer simulations, and remote sensing to measure the condition of ecological systems of the Grouse Creek Mountains and Raft River Mountains, a 1.1 million acre landscape in northwest Utah. NRCS soil surveys and revised LANDFIRE biophysical settings (potential vegetation types) were utilized to describe 17 biophysical settings and develop quantitative state-and-transition management models.

With a vegetation condition map based on remote sensing detection of current vegetation classes from the 17 models, partners proposed both to measure the cumulative impacts of vegetation and fuels management projects from 2002 to 2006 and to develop eight alternative management scenarios, each encompassing modeled management actions and constraints. Management scenarios included whether or not: 1) budgets were restricted to ownership boundaries (Bureau of Land Management, USDA Forest Service, private), 2) biophysical settings (vegetation types) were prioritized for treatment action, 3) fuel breaks were placed along all roads, 4) restoration treatments were placed adjacent to existing desirable vegetation classes, 5) restoration treatments were placed to increase structural vegetation complexity, 6) the costs of archeological surveys, plant seed, and mechanical treatments were reduced, and 7) restoration treatments were only adjacent to human communities-at-risk.

Simulations of alternative management scenarios showed that the lowest average ecological departure was achieved when funding did not respect political boundaries, biophysical settings were not prioritized for treatment, and fuel breaks were implemented along all roads. Results of simulations can guide future management in this and other landscapes of the West. The NW Utah landscape modeling final report (May 2008) is available upon request.

This type of landscape modeling can provide many important planning outcomes, including but not limited to the following: 1) measures of ecological departure (condition) for major vegetation systems, 2) measures

of success for current treatments and strategies, 3) maps of vegetation development classes, 4) models to understand best strategies to reach long-term objectives, and 5) return on investment analyses (understanding of strategies and ecological outcomes within budget constraints).

The Nature Conservancy has led similar collaborative landscape modeling efforts in the Schell Creek Range, NV and Bodie Hills, CA.

Elaine York, The Nature Conservancy, 559 East South Temple, Salt Lake City, UT, 84102, USA, Phone: 801-238-2320, Fax: 801-531-1003, Email: eyork@tnc.org

Notes

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