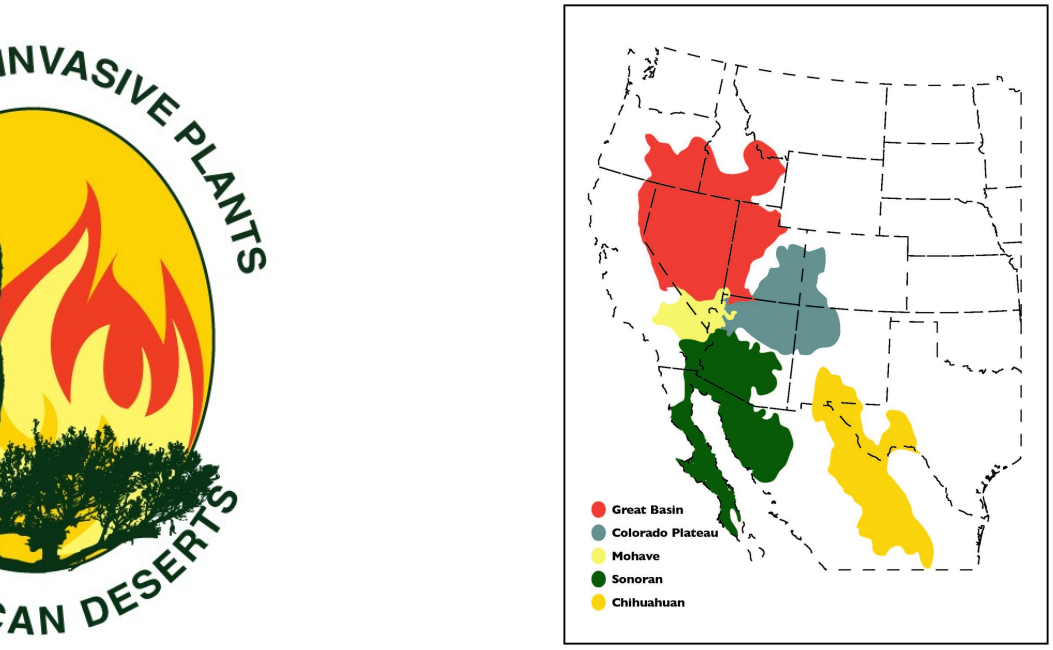
Wildfires and Invasive Plants in American Deserts



Conference and Workshops

The Grand Sierra Resort and Casino
Reno, Nevada
December 9-11, 2008

http://rangelands.org/deserts

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The Wildfires and Invasive Plants in American Deserts is a conference and workshops developed as part of the Society for Range Management's Center for Professional Education and Development. We are very pleased to have the variety of co-sponsors for this conference.

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Wildfires and Invasive Plants in American Deserts

Welcome to an innovative symposium and workshop that will explore the interactions among exotic invasive plants, native plants, and changing wildfire regimes on the Colorado Plateau and in the Sonoran, Chihuahuan, Mojave, and Great Basin deserts of North America. Invasive plants are changing the ecology of the American Deserts, resulting in profound impacts to social, economic, and natural resource values. Examples of exotic invasive plants that change wildfire regimes include, but are not limited to, cheatgrass, red brome, buffelgrass, and medusahead wildrye. Complicating the exotic invasive species/wildfire cycle is the encroachment and potential dominance of invasive native plants such as juniper and pinyon pine in the cold deserts and mesquite and creosote bush in the hot deserts.

The primary goal of this program is to further develop practical frameworks for managing exotic invasive plants and wildfires. To do that, we intend to find out what scientists have learned and what needs further study; what managers in the different desert regions have tried; what on-the-ground management has worked and what hasn't; and identify needs and solutions for effective management.

Information developed through the plenary session and the 6 workshops will be made available through a variety of venues. Abstracts, speaker biographies, and Powerpoint presentations and audio will be available on our website at http://rangelands.org/deserts soon after the conference. Plenary speakers are preparing manuscripts that will be submitted to ***Rangeland Ecology and Management***. Workshop synthesizers are using the information gleaned from each workshop and will write articles for submission to ***Rangelands***. These materials and others will be available for on-the-ground training sessions in different desert regions.

Thank you for your attendance and participation and a special thank you to all the sponsors that helped make this happen!

Executive Program Committee

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Kurt Pregitzer, University of Nevada, Reno
Alix Rogstad, Arizona Sonora Desert Museum
Sherm Swanson, University of Nevada, Reno
Mark Weltz, Agricultural Research Service

Plenary Session

Tuesday, December 9, 2008

Abstracts for most of the plenary session talks begin on page 12. Short biographies of each speaker are on pages 10 and 11.

6:30-8:00 am	**Contintental Breakfast**–Interacting with economists and rural sociologists	Tex Taylor, W-1192 Mariah Evans, WERA-1005
8:00-8:05	Welcome to Reno	Marc Johnson, Provost, University of Nevada, Reno
8:05-8:15	Welcome to Symposium and Workshops	Bud Cribley, BLM Deputy Assistant Director, Renewable Resources & Planning
8:15-8:30	Importance of the Issue from a Public Land Management Perspective	Secretary of the Interior Dirk Kempthorne
8:30-8:45	Importance of the Issue from a Private Land Management Perspective	Jack Alexander, Synergy Resources Solutions and Ken Zimmerman, Lone Tree Cattle Company
8:45-9:30	The State of Invasive Plants and Altered Fire Regimes in American Deserts—A Call to Arms	Julio Betancourt, U.S. Geological Survey
9:30-10:00	Break—Refreshments Provided	
10:00-10:30	Land Use and Plant Invasions in the American Deserts	Dave Pyke, U.S. Geological Survey
10:30-11:00	Invasive Plants that Alter Fire Regimes	Matt Brooks, U.S. Geological Survey and Jeanne Chambers, U.S. Forest Service
11:00-11:30	Wildfires and Climate Change	John Abotzglou, San Jose State Unviersity
11:30-1:00	Luncheon and Program	Gale Buchanan, USDA Under Secretary
1:00-1:30	Altered Ecosystem Processes: Biogeochemical Cycles, Soil Biology and Biogeochemistry	Edith Allen, University of California, Riverside
1:30-2:00	Altered Ecosystem Processes: Watershed Processes and Hydrologic Events	Fred Pierson and Jeff Stone, Agricultural Research Service
2:00-2:30	Cascading Impacts on Biodiversity	Todd Esque, U.S. Geological Survey and John Rotenberry, University of California, Riverside
2:30-3:00	Economic and Social Impacts of Desert Fires and Invasives	Mark Brunson, Utah State University and John Tanaka, Oregon State University
3:00-3:30	Break—Refreshments Provided	
3:30-4:00	Approaches to Managing Altered Fire Regimes and Their Consequences	Jim Douglas, Bureau of Land Management
4:00-4:30	With All of the Tools Available, Why are Invasives and Wildfires Increasing?	Dick Mack, Washington State University
4:30-5:00	Summary and Synthesis	Kurt Pregitzer, University of Nevada, Reno
5:00-8:00	Poster Session, Cash Bar and Buffet Dinner	

Poster Session—5:00-8:00 pm, Tuesday, December 9

Abstracts for most of the posters begin on page 28.

Presenter	Title
Abella, S.R.	Post-Fire Plant Recovery in the Mojave and Sonoran Deserts of Western North America
Abella, S.R., E.C. Engel, C.L. Lund, and J.E. Spencer	Early Post-Fire Succession on a Heavily Visited Mojave Desert Burn: Red Rock Canyon near Las Vegas, Nevada
Bangle, D.N. and S.R. Abella	Management techniques for the control of Sahara mustard (*Brassica tournefortii) in the Mojave Desert*
Booth, D.T. and S.E. Cox	Monitoring Cheatgrass Invasion in Northeast Nevada with Aerial Photography
Caicco, S., F. Edwards, and J. Bair	Vulnerability of the rarest plants in the Great Basin of Nevada to climate change
Clark, P.E., D.E. Johnson, D. Ganskopp, F.B. Pierson, and S.P. Hardegree	Prescribed-fire and environmental effects on cattle distribution patterns within sagebrush steppe rangelands
Clements, C.D., D.N. Harmon, and J.A. Young	Big Sagebrush Seed Bank Densities Following Wildfires
Craig, D.J., J.E. Craig, and S.R. Abella	Implications For Management Prioritization Of Exotic Annual Weed Monitoring Near Roadsides In The Eastern Mojave Desert, Usa
Engel, E.C., S.R. Abella, and C.L. Lund	Seeding effectiveness for eight Mojave Desert perennial species after a 2005 wildfire
Engel, E.C., and S.R. Abella	Vegetation reestablishment of Mojave Desert plant communities after 2005-2006 wildland fires
Garmoe, M. A. Thode, M. Hunter, M. Brooks, C. Decker and K. Fuhrmann	Effectiveness of Imazapic Herbicide in Reducing Post-Fire Cheatgrass Invasion in Zion National Park
Goergen, E. and J. Chambers	Facilitation in the Sagebrush Steppe: The Role of *Lupinus argenteus in Seedling Establishment and Invasion*
Johnson, B., D. Johnson, and W. Miller.	The Effects of Slash Pile Burning on the Soils of Little Valley, NV
Johnson, D.W., J.D. Murphy, R.F. Walker, and W.W. Miller	The Combined Effects of Harvesting and Burning on Nutrient Budgets in a Sierran Forest
Kulpa, K.	Assessing the successful establishment of post-fire seeding in the Great Basin: A focus on Elko County, Nevada
Leger, E.A.	Competition between native grass seedlings and cheatgrass: can we improve restoration success?
Mazzola, M.B. and J.C. Chambers	Effects of *Bromus tectorum invasion on seedling establishment processes in sagebrush steppe ecosystems*
McFadzen, M., and M. Brown	Improving the Science Literacy of Audiences through Visual Communication

Poster Session—5:00-8:00 pm, Tuesday, December 9

Abstracts for most of the posters begin on page 28.

Presenter	Title
McMaster, M. and A. Thode	Effects on native plant regeneration and understory plant community response following post-fire rehabilitation with seeding in the Warm Fire
Mellison, C.	Recent Wildfire Impacts on the Threatened Lahontan Cutthroat Trout
Miller, M.E.	Post-Fire Monitoring of Soil Stability and Dust Emission on the Milford Flat Fire, West-Central Utah
Peppin, D., P.Z. Fulé, J. Beyers, C. Hull Sieg, and M. Hunter	Post-wildfire seeding in forests on Federal lands: trends, costs, effectiveness, and use of native seed
Rao, L.E., E.B. Allen, and T. Meixner	Modeling the effects of nitrogen deposition, precipitation variability, and soil texture on winter annual production and fire risk in the desert
Rau, B.M., Blank, R.R., Chambers, J.C., and D.W. Johnson	Prescribed fire and time: Soil extractable nitrogen and phosphorus dynamics in a Great Basin sagebrush ecosystem
SageSTEP Scientists	SageSTEP: Evaluating the Effects of Fire and Fire Surrogate Treatments in Sagebrush Communities of the Great Basin
Schmelzer, L.	Reducing fuel load of key cheatgrass [Bromus tectorum L.] dominated range sites by the use of fall cattle grazing.
Schmidt, **K.,** S. Swanson, D. Kozlowski, R. Shane, and K. Schmidt.	Effects of Summer Wildfires on Riparian Woody Species, Debris, and Channel Morphology in Northern Nevada
Suazo, A.A., D.J. Craig, and S.R. Abella	Seed removal by granivores in burned Mojave Desert habitat: implications for revegetation
Swanson, J., S. Swanson, B. Schultz, K. McAdoo, and G. McCuin	Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin
Weber, K.L., A.E. Thode, M.L. Brooks, C. Decker, and K.L Fuhrmann	Effectiveness Of Native Seeding And Landscape Scale Imazapic Applications For Controlling Cheatgrass In Zion NP
Zouhar, J.K. Smith, S. Sutherland, and M. Brooks	Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants

Workshops

Wednesday, December 10

Abstracts for most of the workshop talks begin on page 17. Short biographies of each speaker are on pages 10 and 11.

6:30 Breakfast Buffet

Workshop I: Hot Desert Fire and Invasive Species Management: Resources, Strategies, Tactics, and Responses. Moderator: Mark Weltz, Agricultural Research Service. Synthesizer: Alix Rogstad, Arizona Sonora Desert Museum.

7:30	Southern Desert Fire Complex: Case Study	Karen Prentice, Bureau of Land Management
7:50	The Ideal Approach to Fire and Invasive Species Management: Lessons Learned	Sandee Dingman, National Park Sevice
8:10	Special Challenges Working on the Wildland Urban Interface	Julio Betancourt, U.S. Geological Survey
8:30	Roadblocks to Implementation and the Policies that Create Roadblocks	Kerry Baldwin, Pima County (AZ) Natural Resources, Parks, & Recreation
8:50	Panel Discussion—Overcoming Obstacles to Optimal Fire and Invasive Species Management	
9:15	Audience Action Planning Input	

9:30 Break—Refreshments Provided

Workshop II: Cold Desert Fire and Invasive Species Management: Resources, Strategies, Tactics, and Responses. Moderator: Scott Davis, Bureau of Land Management. Synthesizer: Jeanne Chambers, U.S. Forest Service and Elizabeth Leger, University of Nevada, Reno.

10:00	Snake Rivers Birds of Prey National Conservation Study Area: Case Study	John Sullivan, Bureau of Land Management
10:20	Woody Plants and Ecological Thresholds, a Precursor to Exotic Invasives	Steve Bunting, University of Idaho
10:40	Annuals and Fire Cycles on Lands Retaining Few Perennials	Roger Sheley, Agricultural Research Service
11:00	Field Guild to Managing Piñon and Juniper Woodlands in the West	Rick Miller, Oregon State University
11:20	Panel Discussion—Overcoming Obstacles to Optimal Cold Desert Fire and Invasive Species Management	
11:45	Audience Action Planning Input	

12:00 Cold Lunch Buffet

12:15	NASA/ARC Interests and Capabilities Regarding Invasive Species and Fuels Management	Edwin Sheffner, Deputy Chief, Earth Science Division, NASA Ames Research Center

Workshops

Wednesday, December 10

Abstracts for most of the workshop talks begin on page 17. Short biographies of each speaker are on pages 10 and 11.

Workshop III. Effective Invasive Plants Management. Moderator: Will Whelan, The Nature Conservancy. Synthesizer: Nora Devoe, Bureau of Land Management.

1:00	Integrated Buffelgrass Management—What Works and What's Needed: Case Study	Travis Bean, University of Arizona
1:20	Invasive Plant Management by Engaging the Public and Policy Makers	Gordon Brown, National Invasive Species Council
1:40	Practical Approaches for Strategic Treatments at the Landscape Level	John Randall, University of California, Davis and The Nature Conservancy
2:00	Monitoring, Mapping, and Remote Sensing for Adaptive Management	Barron Orr, University of Arizona
2:20	Panel Discussion—Overcoming Obstacles to Effective Invasive Plant Management	
2:45	Audience Action Planning Input	
3:00	Break—Refreshments Provided	

Workshop IV. Fuels Management at the Landscape Scale. Moderator: Brad Washa, Bureau of Land Management. Synthesizer: Sherm Swanson, University of Nevada, Reno.

3:20	The Murphy Complex Fire: Case Study	Jason Davison, Bureau of Land Management
3:40	Managing the Invasive Fine Fuels at the Landscape Scale	Ronald Clementsen, Bureau of Land Management
4:00	Fuels Management Strategies for Woody Natives to Avoid Promoting Invasives	Robin Tausch, U.S. Forest Service
4:20	Breaking Through Roadblocks to Implementation: Policies that Create or Solve Problems	Jesse Juen, Bureau of Land Management
4:40	Panel Discussion—Overcoming Obstacles to Fuels Management at the Landscape Scale	
5:05	Audience Action Planning Input	
5:20	End of Session, Dinner on your own.	

For those interested, the Nevada Section of the Society for Range Management will be having a dinner meeting at Washoe County Extension Office - 5305 Mill Street (Across from UNR Main Station Farm) with a dinner provided by Wolf Pack Meats ($15/person). Call Ken Conley at 775-237-5465 or email bkconley@gmail.com if you are planning on attending. They will begin their meeting at 5:00 pm.

Workshops

Thursday, December 11

Abstracts for most of the workshop talks begin on page 17. Short biographies of each speaker are on pages 10 and 11.

Workshop V. Wildfire Rehabilitation and Restoration: Triage in the Pursuit of Resilience. Moderator: Tamzen Stringham, University of Nevada, Reno. Synthesizer: Charlie Clements, Agricultural Research Service.

8:00	Winnemucca District Experiences: Case Study	Mike Zielinski, Bureau of Land Management
8:20	Assessing the Need for Rehabilitation and Restoration and Monitoring Effectiveness—Describing Triage, Where To and Where Not To Seed	Mike Pellant, Bureau of Land Management
8:40	Best Practices Close to the Ineffective Margins of Successful Seeding	Bruce Roundy, Brigham Young University
9:00	Policy, Prescriptions, Procurements, and Procedures under Pressure: Opportunities for Effectiveness	Dave Repass, Bureau of Land Management
9:20	Panel Discussion—Overcoming Obstacles to Optimum Fire Rehabilitation	
9:45	Audience Action Planning Input	
10:00	Break—Refreshments Provided	

Workshop VI. Wrap-up and Synthesis of Audience Input. Moderator: Linda Coates-Markle, Bureau of Land Management.

10:20	Strategic Planning: It's More than Prioritizing	Alix Rogstad, Arizona Sonora Desert Museum
10:35	Hot Desert Fire Management: Resources, Strategies, Tactics, and Response	Alix Rogstad, Arizona Sonora Desert Museum
10:50	Cold Desert Fire Management: Resources, Strategies, Tactics, and Response	Jeanne Chambers, U.S. Forest Service
11:05	Effective Invasive Weed Management	Nora Devoe, Bureau of Land Management
11:20	Fuels Management at the Landscape Scale	Sherm Swanson, University of Nevada, Reno
11:35	Wildfire Rehabilitation and Restoration: Triage in the Pursuit of Resilience	Charlie Clements, Agricultural Research Service
11:50	Additional Input and Evaluation	

Synthesis teams meet and work to develop Action Plans on Thursday afternoon and Friday morning.

Speaker Brief Biographies

John Abatzoglou—Assistant Research Professor, Department of Meteorology, San Jose State University

Jack D. Alexander, III—founder and president of Synergy Resource Solutions, Inc., a natural resources consulting company in Belgrade Montana

Edith Allen—Professor of Plant Ecology and Natural Resources Extension Specialist , Department of Botany and Plant Sciences, University of California Riverside

Kerry Baldwin—Pima County (AZ) Natural Resources, Parks, & Recreation

Travis Bean—Weed Scientist and Restoration Ecologist working for the University of Arizona School of Natural Resources

Julio L. Betancourt—Project Chief, National Research Program, Water Resources Division, U.S. Geological Survey and adjunct professor in the Departments of Geoscience and Geography at the University of Arizona

Matthew L Brooks—Research Botanist and the Principal Investigator of the U.S. Geological Survey, Western Ecological Research Center, Yosemite Field Station

A. Gordon Brown—Department of the Interior, Invasive Species Coordinator and National Invasive Species Council Liaison

Mark W. Brunson—Professor in the Department of Environment and Society at Utah State University

Gale Buchanan—USDA-Under Secretary for Research, Education, and Economics

Steve Bunting—Professor of Rangeland Ecology and Management at the University of Idaho

Jeanne C. Chambers—Research Ecologist with the Grasslands, Shrublands and Deserts Program of the US Forest Service, Rocky Mountain Research Station in Reno, Nevada.

Darin (Charlie) Clements—Rangeland Scientist, Agricultural Research Service

Ron Clementsen—Bureau of Land Management

Linda Coates-Markle—BLM Liaison for the Society for Range Management

Bud C. Cribley—Deputy Assistant Director, Renewable Resources & Planning, Bureau of Land Management

Scott Davis—Regional Science Coordinator, Bureau of Land Management

Jay Davison—Associate Professor: Central/Northeast Area Forage and Alternative Crops Specialist. University of Nevada Cooperative Extension

Nora Devoe—BLM's Great Basin Cooperative Ecosystems Studies Unit Coordinator and Western Region Science Coordinator

Sandee Dingman—Natural Resource Specialist for the National Park Service, Lake Mead National Recreation Area, Nevada

Jim Douglas—Bureau of Land Management Assistant Director for Fire and Aviation

Todd Esque—Research Ecologist, U.S. Geological Survey, Western Ecological Research Center

Jesse Juen—Associate State Director, New Mexico/Oklahoma/Texas/Kansas, Bureau of Land Management

Dirk Kempthorne—Secretary of the U.S. Department of the Interior

Elizabeth Leger—Assistant Professor, Department of Natural Resources and Environmental Science, University of Nevada, Reno

Richard N. Mack—Professor in the School of Biological Sciences at Washington State University.

Richard Miller—Professor of Range and Fire Science, Eastern Oregon Agricultural Research Center, Oregon State University

Barron J. Orr—Assistant Professor, Geospatial Extension Specialist, Associate Director Arizona Space Grant Consortium, Arizona Remote Sensing Center, University of Arizona

Speaker Brief Biographies

Mike Pellant—rangeland ecologist serving as the coordinator for BLM's Great Basin Restoration Initiative (GBRI)

Fred Pierson—Research Leader and Supervisory Research Hydrologist, USDA Agricultural Research Service, Northwest Watershed Research Center, Boise, Idaho

Karen L. Prentice—Rangeland Management Specialist; Special Projects Manager; District Weed Coordinator; District Emergency Stabilization and Rehabilitation Coordinator, Ely District, Bureau of Land Management

David Pyke—Supervisory Research Ecologist, Forest and Rangeland Ecosystem Science Center, U.S. Geological Survey, Corvallis, OR

John M. Randall—Director of The Nature Conservancy's Global Invasive Species Initiative. Courtesy appointment in the Plant Sciences Department, University of California, Davis

Dave Repass—Emergency Stabilization and Burned Area Rehabilitation Program Lead, BLM Washington Headquarters Office

Alix Rogstad—Science Coordinator and Invasive Species Program Manager within the Center for Sonoran Desert Studies at the Arizona-Sonora Desert Museum in Tucson, Arizona

John Rotenberry—Professor of Biology, Director of Natural Reserve System, University of California, Riverside

Bruce A. Roundy—Professor of Range Science, Department of Plant and Wildlife Sciences, Brigham Young University

Roger L Sheley—Ecologist, Agricultural Research Service, Burns, OR

Jeff Stone—Research Hydrologist, USDA Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona

Tamzen Stringham—Associate Professor, Department of Animal Biotechnology, University of Nevada, Reno

John Sullivan—Manager, BLM Snake River Birds of Prey National Conservation Area, Boise, Idaho

Sherman Swanson—Associate Professor, State Specialist, Department of Natural Resources & Environmental Science, University of Nevada, Reno

Robin Tausch—Research Range Ecologist, Rocky Mountain Research Station, USDA Forest Service, Reno, Nevada

J. Bradley (Brad) Washa—State Fuels Specialist, DOI Bureau of Land Management, Utah State Office, Salt Lake City, Utah

Mark Weltz—Lead scientist for the ARS Exotic and Invasive Weeds Research Unit in Reno, Nevada

Will Whelan—Director of Government Relations for The Nature Conservancy in Idaho

Mike Zielinski—District Soil Scientist, Bureau of Land Management, Winnemucca District, Nevada, program lead for the Soil, Water, Air and Riparian programs

Ken Zimmerman—Lone Tree Cattle Company, Bishop, California; Acting Chair, National Invasive Species Advisory Committee; Chair, Range Mgmt Advisory Committee, California State Board of Forestry

Plenary Session Abstracts

Moderator: **John Tanaka**

Importance of the Issue from a Private Land Management Perspective

Jack Alexander, Synergy Resources Solutions Inc., (MT) and Ken Zimmerman, Lone Tree Cattle Company, Bishop, California; Acting Chair, National Invasive Species Advisory Committee; Chair, Range Mgmt Advisory Committee, California State Board of Forestry.

Fires impact not only the landscapes and wildlife populations of the American Deserts but the humans that are working to earn a living and provide food and fiber from rangeland ecosystems. Ranchers in Great Basin and throughout the arid West depend on a for a ge resource based on both private and public lands. Fires on private lands remove forage, destroy property, and change ecological conditions. While a part of the natural landscape, fires can create imbalance when they are more frequent than the natural fire cycle. A critical challenge created by wildfires are the changes created in grazing rotations and range management efforts. This is complicated by challenges created from trying to balance biological constraints and grazing management with agency requirements when fire crosses multiple ownership boundaries. This presentation will document some of the impacts of fire have on private land owners and discuss options for new thinking to balance fire recovery and management of landscapes for long-term stability.

Natural History of Plant Invasions and Altered Fire Regimes in American Deserts: Historical Perspective and Call to Arms

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

Over the past century, large-scale invasions by Eurasian, Mediterranean and Neotropical grasses have introduced frequent and extensive fires into American dryland ecosystems that supported little or no burning in the pre-European era. Based on the fossil record, these have been the fastest, most pervasive and transforming plant invasions of the last 10,000 years, and they could easily accelerate with warmer and drier winters and longer and hotter growing seasons, conditions that are apt to continue with global warming. These invasions are far enough along to drive long ignition fronts across long stretches of desertscrub into adjoining, more flammable ecosystems, transforming fire-climate dynamics and the entire landscape mosaic. We are clearly on the verge of wholesale ecosystem transformations, and the first line of defense should to immediately adopt an aggressive program of fire suppression in our deserts at a time when we can barely afford to put out forest fires. Despite this grim assessment, heavy public investment in studying and publicizing the ecological impacts of invasions has been matched by an exasperating failure to manage and control them. This inability stems from multiple and intertwined factors. They include, among others, inadequate risk and mitigation assessment through proper detection, mapping, monitoring, and prediction; insufficient appraisal of the economic costs and risks of invasion vs. the costs and benefits of mitigation; contradictory mandates and mixed jurisdiction among governing entities; lack of public awareness and involvement; no guiding, legal framework and lax enforcement for what little there is; inadequate funding; and frankly, a short supply of political will. In the American deserts and adjoining ecosystems, we are standing on a threshold and must now prepare the public for a costly mitigation effort and adaptation to the consequences if those efforts fail.

Land Use and Plant Invasions in the American Deserts

David A. Pyke, U.S. Geological Survey, Forest & Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, OR 97331; Phone: 541-750-7334; FAX: 541-758-8806; david_a_pyke@usgs.gov

Prehistoric plant dispersal generally followed corridors for expansion during climatic shifts or phases of geologic development. Some plants spread via structures that promote propagule dispersal by wind, water or animals. Initial human

population growth and dispersal was dependent on the domestication of organisms and on the ability for those organisms to move to new locations. However, these species generally stayed where they were introduced. In contrast, invasive plants tend proliferate where introduced and spread to new areas, while often having adverse impacts on their new environments. As human travel and commerce has increased, invasion potential and success has increased dramatically. Desert environments within North America are no exception. Mesquite has invaded desert grasslands in the Chihuahuan Desert contributing to soil erosion and altering hydrological processes in these ecosystems. Wide varieties of grasses are invading shrublands of the Sonoran, Mojave and Great Basin Deserts and are increasing fire frequencies dramatically. In desert riparian systems, salt cedar has lowered water tables killing native plants and creating fuel for fires in these systems. Many of these species were intentionally introduced, while others arrived accidentally via imported products. Spread of these species is often enhanced by transportation routes that provide easy vectors for moving these plants to new locations. A number of mechanisms for invasive species success and spread (e.g., enemy escape hypothesis) have been proposed, but no single general theory appears to explain the complexity of plant invasions. Clearly early detection, rapid response, maintenance control, and eradication are warranted in combating invasive species. However, science and policy has tended to overlook the management of pervasive invaders that severely alter ecosystems especially in deserts. Research to maintain and restore native plants into coexistent relationships with these invasives may prove fruitful and provide a viable alternative to current invasive plant management.

Invasive Plants that Alter Fire Regimes in the Deserts of North America

Matt Brooks, U.S. Geological Survey, Western Ecological Research Center, Yosemite Field Station, El Portal CA, matt_brooks@usgs.gov; and **Jeanne Chambers**, USDA Forest Service, Rocky Mountain Research Station, Reno NV, jchambers@fs.fed.us.

Fire regimes are defined by variables related to time, space, and magnitude of burning. They can be strong selective forces that affect the evolution of species, and when fire regimes are rapidly altered, species may not be able to survive under the new conditions. Plant invasions can introduce new fuel characteristics that may affect the ignitability of landscapes and subsequent fire behavior. If the new fuel conditions are promoted by the fires that they cause, then a fire regime might be altered and an invasive plant / fire regime cycle may become established. In cold desert native shrublands of western North America, fire return intervals are moderate to long and fire size and patchiness are variable. Invasions by non-native annual grasses can shorten fire return intervals and lead to larger more contiguous fires. In hot desert native shrublands, fire return intervals are very long, and fires are generally small and patchy. Invasions by non-native annual and perennial grasses can create conditions that shorten fire return intervals, and produce larger more contiguous fires. In native desert grasslands, fire return intervals are relatively short and of low intensity. Fire suppression and expansion of native woody species from adjacent ranges can increase fire return intervals and create more intense fires. In native desert riparian zones, fires return intervals are moderate in length and intensity, and are relatively small and patchy. Invasion of non-native species can increase the frequency, intensity, and size of fires. Prevention of these invasive plant / fire regime cycles ideally begins with early detection and eradication of invaders likely to cause change. Maintenance of ecosystem integrity can also reduce invasion potential. After these cycles have become established, restoration treatments must focus on restoring pre-invasion fuels conditions.

Climate Change Implications for Future Fire Danger and Invasives across the American Deserts

John T. Abatzoglou[1,2*] and **Crystal A. Kolden**[2]. [1]San Jose State University, San Jose, California; [2]Desert Research Institute, Reno, Nevada; [*]Corresponding Author: John.Abatzoglou@dri.edu

The western deserts of the US, which for decades remained relatively stable from an ecological perspective, have recently seen widespread change from two primary mechanisms: invasive flora species and wildfire. The positive feedback relationship between these two agents has fueled speculation that fire regimes and plant communities in desert biomes will transition across a threshold into a new state characterized by higher fire frequency and a permanent loss of native desert plant communities, including iconic flora such as the Saguaro cactus (*Carnegiea gigantean*). Further confounding

this potential transition is the spectre of climate change in western deserts. Climate change influences the fire-invasive species feedback cycle through two primary paths: 1) altering the geographic range where an invasive species can viably exist given its bioclimatic envelope; and 2) altering the wildfire disturbance regimes which enhance opportunities for invasive spread and maintenance. Since climate change projections show a spatiotemporally varied response across the deserts of the western US, it is critical from a management perspective to quantify which species and regions will see the greatest potential impacts from climate change in order to prioritize resources for counteractive measures. We utilize downscaled climate model output to illustrate the impacts of climate change on management of the fire-invasive species relationship through both changes in potential geographic range, and changes in fire danger. First, we examine the potential for changes in geographic ranges of invasive annual grasses through a simple deterministic model that incorporates abiotic climate change information. Second, we examine projected changes in the length of fire season, as well as the intensity and frequency of extreme fire danger, as defined by the National Fire Danger Rating System. We conclude with a set of recommendations to resolve knowledge gaps in order to produce better projections of climate change impacts on desert ecosystems.

Biogeochemical Cycles and Soil Biology Following Fire and Invasive Species in the Desert

Edith B. Allen, **Robert J. Steers** and **Sara Jo Dickens**. *Department of Botany and Plant Sciences and Center for Conservation Biology, University of California, Riverside*

Both fire and invasive species may cause changes in soil biogeochemical cycles and biological properties of arid and semiarid soils. These changes are permanent under persistent invasive species, while soil may recover from fire impacts during succession. The most severe effects of fire occur under high temperatures in vegetation with high fuel buildup and residual soil moisture that conducts heat downward, both conditions less likely to occur in deserts and semiarid lands. Soil is a good insulator, so soil microorganisms will survive a few cm deep even in hot surface fires. Immediately post-fire there is often an increase in mineral N and a decrease in soil C and organic N, as occurred in a 3 to 29 year fire chronosequence in the Coachella Valley, California. Following fire these sites had increased growth of invasive nitrophilous grasses. Sugar addition to immobilize N on burned soils had variable results in different studies, sometimes producing relatively greater growth of native than invasive herbs, but other times also slowing growth of natives sensitive to low soil N. Invasive species may either increase or decrease soil N and C depending on site conditions. In the case of sage scrub invaded by Mediterranean annual grasses there was an increase in mineral N, while cheatgrass invasions have resulted in both increased and decreased N mineralization depending on soils and vegetation prior to invasion. Attempts to use fire as a management tool to reverse soil impacts of invasive species have not resulted in significant reductions of C and N. Land managers worry most about loss of N during fire, but the mineralization of N is often so high after fire that subsequent productivity cancels N losses. Even frequent fires have not caused reduced soil N through volatilization, and loss of soil productivity through erosion is the main concern following fire.

Hydrologic and Erosional Impacts of Altered Fire Regimes and Plant Invasions

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Healthy rangeland ecosystems consist of functional and structural biotic communities that limit soil redistribution and loss by water. Healthy rangelands effectively capture, store, and release water, resist alteration of these functions, and recover these capacities post-disturbance. Rangeland fire is a natural disturbance and its occurrence within consistent return intervals is commonly associated with healthy functioning rangelands. Altered fire regimes can have detrimental effects on vegetative structure and hydrologic function of rangeland communities. Fire or the lack of burning can increase the abundance of invasive species, which in turn may alter fire behavior and fire

regimes. Such landscape scale alterations often sustain the presence of invasive species and the fire regimes that propagate them. The hydrologic and erosional responses to these changes vary with pre- and post-fire plant communities, climate, geomorphology, and soil characteristics. Conversion of shrublands and perennial grasslands to annual grass communities commonly facilitates more frequent and intense fires. Conversely, long-term fire suppression on shrub steppe can facilitate increased tree dominance, decreased shrub and herbaceous species coverage, and increased bare soil exposure. In both scenarios, increased bare soil exposure amplifies surface runoff and soil loss at the hillslope scale from rainsplash, sheetwash, and concentrated flow processes. Under some conditions simultaneous vegetation invasions and drought conditions have been associated with increased frequency and spatial expanse of severe wildfires. These concurrent changes at the landscape level increase the risk of watershed scale mass flooding and erosion events. Current hydrologic and erosion risk assessments are hampered by the vastness of species invasions across bio-regions, the small scales of historic studies, and lack of long-duration experiments. Our advancement in the understanding of fire and invasive species impacts on hydrologic processes requires further research on bio-region specific invasions (fire and non-fire related) across multiple spatial and temporal scales.

Fire Effects on Biological Diversity in Hot Desert Ecoregions of North America

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Confronted with recently burned desert landscapes we often ask, “How much diversity has been lost?”, and “What measures are necessary to stimulate recovery of diversity in burned areas?” One of the most important landscape scale measurements to gauge the impact of fires is biological diversity. We discuss the importance of plant structural diversity in desert shrub and succulent-scrub communities with regard to food, cover and microclimate for associated desert animals and describe important ecological linkages between animals and native and invasive plant species. We will also explore how the scale of wildfires affects biological diversity and how vulnerability and resilience of major plant and animal taxonomic groups vary in response to fires. Finally, we cannot be successful in understanding disturbance ecology of deserts without consideration for other landscape scale influences (e.g. transportation corridors, urban footprint, energy development) which independently or synergistically challenges the maintenance of biological diversity of deserts.

Economic and Social Impacts of Desert Fires and Invasives

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Wildfire and invasive plants affect social systems in ways that extend beyond economic impacts. When wildfire hits a community, unifying effects can occur as residents “pull together” to attack the fire, meet victims’ needs and begin rebuilding. However, fragmentation also occurs as conflicts arise over the assign of blame or distribution of post-fire assistance. Biological invasions may have less community-level impact because change occurs more slowly, but conflicts do arise over how weed threats should be managed (e.g., grazing vs. herbicides vs. prescribed fire). Disagreements also arise over proactive responses to both types of disturbance. We will present research showing how rural and urban populations differ in their beliefs about causes and responses to weed and wildfire threats, and also on how “new rural” residents of small desert acreages are responding. Included in these responses are the economic impacts on ranching operations from invasive annual plants and changing fire regimes.

Approaches to Managing Altered Fire Regimes and Their Consequences

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Fire is changing the great deserts of North America, and that change is literally being fueled by invasive, fire-prone plant species. In what has been termed a 'biological emergency,' the spread of fire-prone, noxious weeds is altering the fire regime of desert ecosystems by exposing native plants to abnormally high fire intensities and abnormally frequent fire return intervals. Large wildland fires and fire complexes are becoming more common across the American West—a trend which is evident in desert ecosystems as well as in forest ecosystems. The BLM manages over 260 million acres in North America, including an estimated 65 million acres in the Great Basin desert ecosystem; some 12 million acres in the Mojave desert ecosystem; approximately 11 million acres in the Sonoran desert; and approximately 5 million acres in the Chihuahuan desert. Each of these ecosystems has experienced mega-fires since just the middle of this decade. The BLM is working to adapt how it responds to changes in fire regimes due to altered ecosystems. We are adapting suppression methods—like using smokejumpers to attack emerging large fires in desert ecosystems and shifting resources away from extended attack toward initial attack. The BLM is also supporting projects to explore new alternatives in suppression, fire prevention and post-fire rehabilitation. However, the changes wrought by invasive weeds and other factors defy easy solutions. The BLM lacks biological, physiological and operational tools to achieve our goals in protecting and restoring desert ecosystems. Our ability to respond appropriately to fires in the deserts—through pre-fire vegetative treatments, suppression actions on fires, and post-fire actions—requires additional knowledge, tools and skills.

With all of the tools available, why are invasive species and wildfires increasing?

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Bromus tectorum (cheatgrass), the single most important fuel for wildfires in the arid Intermountain West, arrived in the region before 1900 and in less than 40 years it had invaded much of the steppe. Its role as the undisputed plant dominant on > 200,000 km^2 of rangeland and a persistent weed in croplands remains secure, despite repeated and varied attempts to control it on a regional basis. Why? This failure to successfully combat cheatgrass reflects its formidable array of plant attributes and pre-adaptation to the environments of the Intermountain West and a history of control that has included varied but largely ineffective (or ineffectively applied) techniques. Yet the failure to convince the public and public policy-makers as to the immense damage this invader causes to the regional environment and economy looms as the most important missing component for its control. Fortunately, the public does support spending public funds to combat harmful organisms. And while sustained campaigns against human parasites (e.g. *Mycobacterium tuberculosis*, poliovirus) are well known, plant invaders have also prompted similar commitment: the on-going 50-year eradication effort against witchweed (*Striga asiatica*) in the Carolinas and the epic, continent-wide near eradication of the *Berberis vulgaris* (European barberry), the alternate host for the stem rust of wheat, are under-publicized or overlooked altogether. Although tools, tactics and strategies vary, the essential component of these successful campaigns was public acceptance of the cost and awareness of the risks of not incurring this cost. In contrast, the history of attempts to curb the spread of other non-native pests is littered with examples in which public support was allowed to waver or worse, not solicited at all.

Workshop I Abstracts – Hot Deserts

Moderator: **Mark Weltz**; Synthesizer: **Alix Rogstad**

Southern Nevada Fire Complex: Case Study

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Selection and implementation of post-fire management response is difficult in Mohave and Mohave transitional communities. Difficulty arises from a poor understanding of the natural range of variation in fire regime characteristics and the effects of fire on these plant communities provides. Predicting the response of some portions of these communities to active management such as seeding can also be difficult. Variable management goals and landownership status, specific requirements of funding, material availability, and unpredictable weather patterns further muddle the mix.

In 2005, eleven fires of the Southern Nevada Complex burned approximately 740,000 acres in Nevada and Utah. A National Interagency Burned Area Emergency Response team prepared a regional response plan for the Nevada portions of the Complex. Within the bounds of perceived ecological reality and agency policy, this plan was strongly affected by the knowledge and experience, other workloads, and professional networks of assigned personnel. Specific concerns, such as for Wilderness, desert tortoise, requirements of funding, and public land user interests also shaped the plan. Staffing, timing of plan approval, the federal fiscal calendar, timing of funding distribution, and commercial seed availability drove plan implementation.

A union of ground truthing and remote sensing was used during the assessment, planning, and monitoring phases of this project. This union helped project staff efficiently derive a detailed burn area perimeter, develop soil burn severity class maps, assess and prioritize candidate seeding areas, identify locations for ground-based monitoring, track vegetation responses in seeded and non-seeded areas, and assist in mapping post-fire patterns of annual and perennial grass dominance.

The Ideal Approach to Fire and Invasive Species Management: Lessons Learned

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A life-cycle approach is needed to address invasive species and wildland fire management. First, a comprehensive Fire Management Plan is needed to establish goals and objectives as well as to identify where and under what conditions fire and/or fire management activities may promote native plant communities or promote non-native species. Such Plans need to analyze and synthesize existing data and literature into local operational guidelines, including the locations and probable responses of invasive plants and native plant communities, so that the information is immediately available to fire managers when ignitions occur. Fire Management Plans should also identify fire effects monitoring and research strategies to increase knowledge of relationship between fire and invasive plants. When a fire does occur, Resource Advisors and local operational guidelines should be used to inform incident managers of invasive species locations and concerns as well as fire and incident management strategies and/or tactics that may serve to reduce or increase their spread. Post-fire rehabilitation and restoration efforts should focus on invasive species prevention through manipulation of resource availability and/or propagule pressure. Where feasible, research and monitoring need to be included in post-fire efforts so that assumptions are tested and new knowledge is gained. Finally, lessons learned need to be incorporated into updated Fire Management Plans and shared with other land managers.

Special Challenges Working on the Wildland Urban Interface

Julio Betancourt (USGS, Tucson, AZ)

View and discuss the video “Buffelgrass Invasion” available at http://www.youtube.com/watch?v=nQtIVzSrqZY.

Roadblocks to Implementation and the Policies that Create Roadblocks

Kerry Baldwin (Pima County Natural Resources, Parks & Recreation - Tucson, AZ

Workshop II Abstracts – Cold Deserts

Moderator: **Scott Davis**; Synthesizers: **Jeanne Chambers and Beth Leger**

Impacts of Wildfire and Cheatgrass Infestation in the Snake River Birds of Prey National Conservation Area

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The 485,000 acre Snake River Birds of Prey National Conservation Area (NCA) was established in 1993 by Public Law 103-64 to conserve, protect, and enhance raptor populations and habitats along 81 miles of the Snake River Canyon in southwest Idaho. The NCA is located within a 30-minute drive of Boise and about half of Idaho's population, and supports the densest population of nesting raptors in North America. Over 700 raptor pairs, representing 15 species, nest in the NCA each spring, with nine other species migrating through the area during various seasons.

Since 1980, over 300,000 acres of the NCA's Wyoming big sagebrush and salt desert shrub communities have burned (some areas as many as five times), and have been replaced with exotic annual grasses and weeds, particularly cheatgrass. This landscape-scale change to annual vegetation communities has caused black-tailed jackrabbit populations to plummet, which is reflected by reduced golden eagle nesting populations. Likewise, this ecosystem change has destabilized Piute ground squirrel populations, the primary prey for the NCA's prairie falcons. Wide yearly fluctuations in ground squirrel populations are reflected by subsequent fluctuations in annual prairie falcon nesting success and productivity.

Although various human activities (off-road vehicle activity, military training, livestock grazing, etc.) affect raptor and raptor prey populations, the loss of native shrub communities, exotic annual weed infestations, and the escalating wildfire cycle have had the most significant and profound effects.

To accomplish the NCA's mission, the new NCA Resource Management Plan emphasizes aggressive wildfire suppression; establishes long-term, landscape-level habitat restoration and fuels management objectives; prescribes management actions that support and protect remnant shrublands and newly restored habitat areas; and provides for up to 5,000 acres to support habitat restoration-related research.

Woody Plants and Ecological Thresholds, a Precursor to Exotic Invasive Species

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The use of the threshold concept has become commonly used in ecology in recent years for explaining many phenomena. Understanding thresholds is critical to the development and use of State-and-Transition Models. In general, thresholds can be thought of as those conditions that result in a change in the behavior of a system. With respect to State-and-Transition Models, they have been defined as "representing conditions sufficient to modify ecosystem structure beyond the limits of ecological resilience, resulting in the formation of alternative states". The increase in abundance or encroachment of woody plants into many rangeland vegetation types has the potential to sufficiently modify the ecosystem structure beyond the limits of ecological resilience. This may be particularly important when this modification is associated with exotic invasive species. However, alternative states may be created even in the absence of exotic invasive species. The persistence of the alternative state may be enhanced though feedback mechanisms involving many simultaneously occurring factors such as loss of native species seed sources, reduction in native species recruitment, loss of soil fungal mycorrhizae and changes in the fire regime.

Annuals and Fire Cycles on Lands Retaining Few Perennials

Roger Sheley, Rangeland Weed Ecologist, Agricultural Research Service, Burns, OR

Invasive plant management in intensive agricultural systems allows for regular inputs (chemical, biological, or mechanical weed control) and the system is often reset on an annual basis (e.g. plowed and replanted). This is not the case in wildland systems where major inputs are either absent or occur infrequently. Concepts such as IPM which work in intensive agricultural settings may not apply in extensively-managed wildland. However, advances in the ecological sciences may prove more appropriate for managing invasions of wildland ecosystems. An understanding of plant community change over time (termed succession) will be critical in applying subtle, well-designed treatments, which over time can shift the balance away from invasive weeds and toward desirable species. We suggest that wildland invasive plant management must include the understanding and manipulation of the underlying ecological processes which allow invasive species to establish and dominate. Simply killing the weed amounts to treating a symptom in many cases, and may not address the root cause of the problem. We propose a blending of plant community ecology and IPM in a way that provides a unifying ecological theory for managing invasive species in wildlands. To extend the concept of ecologically-based IPM, we formulated a comprehensive, unified framework that helps managers and ecologists conceptualize the processes occurring within annual dominated ecosystems and how these processes direct plant community trajectories toward perennial dominated systems.

Field Guild to Managing Piñon and Juniper Woodlands in the West

Richard F. Miller, Professor of Range and Fire Science, Eastern Oregon Agricultural Research Center, Oregon State University, Corvallis OR

Developing a strategy to obtain desired management goals can be a difficult task due to the complexity and uncertainty of how vegetation, soils, hydrologic function, and climate will interact with management treatments. The development of a potentially successful management strategy can be increased by asking the right set of questions. These questions primarily focus on identifying landscape and vegetation attributes of the site and surrounding area, evaluating risks, and selecting the best set of treatments. Important questions relate to evaluating the kind of site (potential vegetation, soils, topographic position, etc.) the current state of the site (successional, hydrologic, etc.), what components need to be restored, how the site fits in with the overall landscape mosaic, and what are the long term goals and objectives for the area or region. This presentation is based on two field guides developed to help field biologists, land managers, and private landowners conduct rapid qualitative field assessments directed towards identifying the type of site, current condition, the level of risk for success or failure, and the type of treatment that may be the most appropriate. The field guides present a set of questions to be addressed and on-site evidence to be evaluated. Examples will be presented related to piñon and juniper woodlands and shrub-steppe communities encroached by conifers.

Workshop III Abstracts – Invasive Plants

Moderator: **Will Whelan**; Synthesizer: **Nora Devoe**

Integrated Buffelgrass Management - What Works & What's Needed: Case Study

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Rapid spread of buffelgrass (Pennisetum ciliare) and conversion of fireproof desert to flammable grassland rivals urban growth and water as the most pressing environmental issue in Southern Arizona. Without coordinated, decisive, and effective action, the region faces destructive fires, undermined conservation efforts, and serious economic impacts. Successful buffelgrass management will require coordinated action taking place across property lines and jurisdictional boundaries, and future success will demand a multi-year, integrated set of actions designed to maximize efficiency and effectiveness of treatment activities. To this end, a 5-yr strategic plan has been developed and a regional, cooperative coordinating body created to organize and prioritize control, research, and outreach efforts. A case study will be presented documenting the successes made and hurdles faced by the Buffelgrass Working Group and newly formed Southern Arizona Buffelgrass Coordination Center.

Invasive Plant Management by Engaging the Public and Policy Makers

Gordon Brown, Department of the Interior Invasive Species Coordinator & Liaison to the National Invasive Species Council (NISC), Email: a_gordon_brown@ios.doi.gov

Invasive plants are being introduced and spread at increasing rates across the desert West. At a minimum, their impacts affect wildfire cycles, nutrient cycling, and water use. Novel genetic breeding tools speed development and market availability of new cultivars, increasing the propagule pressure on heritage ecosystems. The public sees these new arrivals in two polarizing views – one, an opportunity to exploit new niches for the ornamental, forage, and energy trade, the second, an ill-conceived misappropriation of cost-benefit analysis likely to be detrimental to native species. Our scientists and citizens are caught in the balance, weighing the pros and cons as policymakers strive to simultaneously encourage productive uses and conserve nature and natural resources. This talk will explore how citizen activism fueled by insightful science and modeling builds momentum for policy change when governments incorporate the human dimensions of invasive plant management. The role of state invasive species councils and regional panels will be considered as a necessary link between on-the-ground and national efforts at regulatory and non-regulatory approaches.

Practical Approaches for Strategic Treatments at the Landscape Scale

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Protecting the American deserts' native biota and the ecosystem processes they depend on requires addressing invasive plants on a landscape scale. Highest priority should be given to quickly identifying and eradicating or containing new invaders with potential to spread and cause harm either under present conditions or a changing climate (e.g. sweet resinbush, *Euryops multifidus*, in Arizona). It is necessary to identify high priority areas for the prevention or management of widespread invaders as well as lower priority areas where actions can be taken to promote the survival of at least a subset of valued native biota despite the presence of invaders. Some widespread desert invaders are good candidates for biological control which, if successful, will significantly reduce their abundance and impacts on landscape scales.

Large-scale mapping of the distribution of invasives and the native biota they threaten allows managers to set priorities for landscape-scale management. Some invasive plants like cheatgrass (*Bromus tectorum*) and red brome (*B. madritensis* ssp. *rubens*) are so widespread that priority must be given to keeping them out of remaining uninfested areas. Areas infested with these and other widespread invaders like buffelgrass, (*Cenchrus ciliaris*) and Lehmann's lovegrass (*Eragrostis lehmanniana*), which also harbor concentrations of valued native species may be subject to control via ecosystem-process management such as prescribed fire or the manipulation of soil nutrients. Lower-priority areas may be less-intensively managed to promote sub-sets of the native biota (e.g. rodents and the raptor that prey on them) despite the presence of the invaders. The biocontrol program for tamarisk (a.k.a. saltcedar, *Tamarix* spp.) appears to be on track to significantly reduce tamarisk abundances and impacts on desert riparian and wetland habitats at least in the Great Basin and northern Mojave deserts and perhaps to the south as well. Several other invaders may be targeted for biological control.

Monitoring, Mapping, and Remote Sensing for Adaptive Management

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Over the past decade we have witnessed extraordinary advances in the application of geospatial technology for the adaptive management of wildfire and invasive species. Barriers to wider adoption of these advances – cost, expertise, and the jurisdictional allocation of resources – remain, particularly where collaboration and volunteers are central to success. The mapping and monitoring of invasive species and community assessment of wildfire risk are two areas where non-experts are essential to successful adaptive management. In this presentation, we introduce a variety of field and web-based tools that are making it possible to address these challenges. The geospatial tool kit (GTK), a combination of GPS and a handheld computer with GIS and remote sensing data is an example of a field-based solution to the mapping challenge. Volunteered geographic information, now commonplace on Web sites such as Google Maps and Wikimapia, is now being exploited to support citizen science initiatives. Earth systems science research and the development on decision support systems are moving beyond domain-specific functionality (e.g., invasive species detection; wildfire monitoring) so that managers and stakeholders can integrate the human and biophysical dimensions wildfire and invasive species. Cross-jurisdictional databases and multi-criteria decision making tools are permitting the management of resources across agencies as well as assessment of tradeoffs through synthesis among disparate parameters (e.g., risk vs. values at risk) and potentially competing interests. This presentation will introduce a number of these tools with the aim of encouraging discussion about increasing our capacity for collaborative mitigation and management of wildfire and invasive species.

Workshop IV Abstracts – Fuels

Moderator: **Brad Washa**; Synthesizer: **Sherm Swanson**

Interactions Among Livestock Grazing, Vegetation Type, and Fire Behavior in the Murphy Wildland Fire Complex in Idaho and Nevada, July 2007

Karen Launchbaugh, University of Idaho; **Bob Brammer**, Idaho Department of Lands; **Matthew L. Brooks**, U.S. Geological Survey; **Stephen Bunting**, University of Idaho; **Patrick Clark**, U.S. Department of Agriculture, Agricultural Research Service; **Jay Davison**, University of Nevada; **Mark Fleming**, Idaho Department of Fish and Game; **Ron Kay**, Idaho State Department of Agriculture; **Mike Pellant**, Bureau of Land Management; **David A. Pyke**, U.S. Geological Survey; and **Bruce Wylie**, ASRC Research and Technology Solutions contractor to U.S. Geological Survey

A series of wildland fires were ignited by lightning in sagebrush and grassland communities near the Idaho-Nevada border southwest of Twin Falls, Idaho in July 2007. The fires burned for over two weeks and encompassed more than 650,000 acres. A team of scientists, habitat specialists, and land managers was called together by Tom Dyer, Idaho BLM State Director, to examine initial information from the Murphy Wildland Fire Complex in relation to plant communities and patterns of livestock grazing. Three approaches were used to examine this topic: (1) identify potential for livestock grazing to modify fuel loads and affect fire behavior using fire models; (2) compare levels of fuel consumed within and among major vegetation types; and (3) examine several observed lines of discontinuity in fuel consumed to determine what factors created these contrasts.

The team found that much of the Murphy Wildland Fire Complex burned under extreme fuel and weather conditions that likely overshadowed livestock grazing as a factor influencing fire extent and fuel consumption in many areas where these fires burned. Differences and abrupt contrast lines in the level of fuels consumed were affected mostly by the plant communities that existed on a site before fire. A few abrupt contrasts in burn severity coincided with apparent differences in grazing patterns of livestock, observed as fence-line contrasts. Fire modeling revealed that grazing in grassland vegetation can reduce surface rate of spread and fire-line intensity to a greater extent than in shrubland types. Under extreme fire conditions (low fuel moisture, high temperatures, and gusty winds), grazing applied at moderate utilization levels has limited or negligible effects on fire behavior. However, when weather and fuel-moisture conditions are less extreme, grazing may reduce the rate of spread and intensity of fires allowing for patchy burns with low levels of fuel consumption. Additional research was recommended.

Mojave Desert Initiative

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The purpose of the Mojave Desert Initiative (MDI) is to provide a healthy functioning landscape with ecological diversity for current and future generations. The goals of the MDI are to protect remaining unburned Mojave Desert vegetation and reduce the likelihood of re-burning to prevent habitat conversion to non-native grasslands; restore strategically located islands, key habitat areas, and corridors that provide habitat connectivity to other areas of quality habitat; improve communication, collaboration, and coordination, both internally and externally and; leverage funding with all possible partners (Federal & Non-federal) to achieve maximum long term results to the extent possible.

Strategies for Woody Natives to Avoid Promoting Invasives

Robin Tausch, Rocky Mountain Research Station

The ability of Great Basin Ecosystems dominated by woody natives to resist dominance by invasives, particularly after disturbance, is dependent on the robustness of their perennial herbaceous component. Where that herbaceous component is weak or largely absent the risk of such a conversion is high. The current trends, particularly in Great Basin woodlands, is toward an increasing loss of this vital herbaceous component. If done early enough, before significant losses in the herbaceous component occur, management changes or active restoration can often more easily stop and reverse this loss. Once the herbaceous component is largely lost it becomes much more difficult to avoid dominance by invasives.

Fuels Management on the Landscape Scale: Breaking Through Roadblocks to Implementation

Jesse Juen, New Mexico Associate State Director, Bureau of Land Management

How do you go about bringing back native grasslands, woodlands and riparian areas to their pre-1900 ecological states, areas that have been heavily impacted by population growth, transportation networks, oil and gas development and livestock grazing among other human activities?

In New Mexico it's being done under an effort known as Restore New Mexico, an aggressive partnership launched by BLM in 2005 to restore land health and productivity across entire landscapes.

As the project now approaches its 1,000,000th treated acre, the lessons learned during the first three years of the project have wide applications throughout the West. Working closely with a myriad of partners, we've overcome obstacles to increase the scale of our treatments, accelerate our pace, develop agreements for use across multi-jurisdictional landscapes, involve more diverse partners, expand the tools in our toolbox and overcome difficulties that might have otherwise sidetracked our efforts to restore and reclaim degraded landscapes.

Redefining the way we work with our partners has been critical; we engage them on their terms, focus on shared interests and goals, and have developed personal relationships that have lead to unexpected opportunities and accomplishments.

Restore New Mexico is about many things: restoring landscapes, reversing expansion of invasive species, re-establishing natural fire regimes, reclaiming impacted areas, re-introduce extirpated wildlife, and improving water quality and quantity through the power of partnering. Learn how we've come so far in such a short time and take home ideas that can be applied anywhere.

Workshop V Abstracts – Triage

Moderator: **Tamzen Stringham**; Synthesizer: **Charlie Clements**

Resilience, it's the Perennials Stupid! Case Study (Winnemucca District Experiences)

Michael Zielinski (Compilation by Aliana Reichert-Eberhardt), Soil Scientist, BLM – Winnemucca Field Office, 5100 E. Winnemucca Blvd, Winnemucca, NV 89445, 775-623-1567, Mike_Zielinski@blm.gov.

The Bureau of Land Management, Winnemucca District is located in northwest Nevada approximately 10 million acres in size of those 2.5 million acres have burned in the last 24 years. This presentation is a broad overview of monitoring conducted on sagebrush communities and there response. The dominate five sagebrush types affected are: Wyoming big sagebrush *Artemisia tridentate wyomingensis,* mountain big sagebrush *Artemisia tridentate vaseyana,* gray low sagebrush *Artemisia arbuscula arbuscula,* little sagebrush *Artemisia arbuscula longicaulis* and basin big sagebrush *Artemisia tridentate tridentata.*

When sagebrush dominated areas largely devoid of herbaceous perennials burn, it often transitions to annual plant species precluding the establishment of sagebrush. A perennial herbaceous under story with native or introduced species accelerate sagebrush establishment.

Drill seeding of Wyoming big sagebrush seed can be effective when pre-burn conditions were sagebrush. Two basic rules apply: one - grass seed must be at less than 15 live seeds per square foot and two - sagebrush seeding is conducted prior to February. Higher grass seeding rate preclude the establishment of Wyoming big sagebrush seedlings. This has important implication on the management of sagebrush communities and fire rehabilitation treatments.

Assessing the Need for Rehabilitation and Restoration and Monitoring Effectiveness: Describing Triage and Where and Where Not to Seed

Mike Pellant, Great Basin Restoration Initiative Coordinator, Bureau of Land Management, Boise, ID Email: Mike_Pellant@blm.gov.

Invasive species in American Deserts have complicated manager's decisions in planning post-burn rehabilitation treatments and restoration treatments not associated with a wildfire. A question common to both rehabilitation and restoration planning is whether invasive species are present in sufficient quantities to: 1) Require seeding due to lack of desirable residual species, and if so, 2) Is a pretreatment to reduce invasive species competition necessary prior to seeding desirable species? These questions are easier to answer for restoration treatments since the existing plant community is still present and the ratio to natives to desirable species is easily observed or measured. Assessing land burned by a wildfire for rehabilitation potential is complicated by not only the lack of plants but also by the severity of the fire and its affect on plant survival and post-fire composition. Another question that managers must answer in addition to whether seeding is needed or not, is what to seed….natives, introduced species, or a combination of both? Finally, seedings should be designed to be compatible with post-restoration or rehabilitation management and climate. For example, will the post-treatment grazing management (both short and long term) maintain the survival and vigor of the species seeded? Are the seeded species and/or ecotypes potentially adapted to the climate that will exist throughout their life cycle? Potential solutions include the use of state and transition models in treatment planning, a better understanding of invasive species and desired species thresholds, good pre-treatment vegetation composition data and maps, and adequate invasive species control prior to seeding. A feedback loop utilizing effectiveness monitoring from previous treatments is essential. Other strategies and tools will be discussed in this presentation.

Best Practices Close to the Ineffective Margins of Successful Seeding

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Recent wildfires in the Mojave, Sonoran, and Great Basin Deserts have required agencies to conduct emergency fire and burned area emergency rehabilitation seedings on extensive lands traditionally considered too dry for large-scale direct seeding success (<250 mm annual precipitation). Besides soil conservation, these seedings are often aimed at reducing the dominance of invasive weeds. These weeds are considered to be major contributors to wildfires in some of the non-fire-adapted communities, such as blackbrush and salt desert shrub. Over a century of rangeland revegetation research and practice suggests some practices to increase probability of revegetation success: seed in areas of adequate precipitation, prepare and sow seeds to meet burial and establishment requirements, seed sufficient rates of adapted species, and manage seedings to support persistence. Where limited precipitation represents high risk to direct seeding, probability of success can be increased by applying these principles and by maximizing water availability with soil surface modifications, timing of sowing, techniques to bury seeds, or use of the most proven plant materials. None of these techniques ensures success in any given year. Successful rehabilitation on drier areas may require development or determination of specially-adapted plant materials, weed control and water concentration strategies, and seeding on wetter years.

Policy, Prescriptions, Procurements, and Procedures under Pressure: Opportunities for Effectiveness

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When dealing with a complex emergency, being prepared is often the most effective way to handle the situation. The Department of the Interior's Emergency Stabilization and Rehabilitation programs have been established to deal with post-fire issues for the protection of human life and property and critical natural and cultural resources for lands unlikely to recover naturally. These programs are the primary linkage between immediate on-the-ground wildland fire management and longer-term management of natural and cultural resources.

Policy – Recent work on refinement of definitions to implement cost containment strategies has expanded program scope and ability to address broad range of issues. Conversely, a finer focus has been brought into budget procedures by establishing detailed prioritization and decision support tools to direct funds to highest needs within the Department.

Planning /Prescriptions – The need to take action is often paramount and tools are in place to expedite plan creation, review, approval, and NEPA documentation. A wide range of actions are taken, all based on the direct impacts caused by the wildfire and ability to be effective with treatments to address those potential current and future impacts.

Procurements – Large dollar amounts, within short time frames, working within the Federal acquisition regulations as well as proactive measures to be prepared in the event of a disaster.

Procedures – Follow-up tracking is done to document how the treatment was implemented and if there were any derivations due to unforeseen circumstances. Comprehensive monitoring of treatments is done to determine if planned goals and objectives are reached and to what extent the actions could be considered a success. Monitoring also helps the project managers understand where efficiencies can be taken and share lessons learned with others facing the same problems.

Opportunities for effectiveness – The programs need focus. Due to the degree of difficulty in dealing with expansion of invasive plants and landscape level fires, a short term, solitary effort will fail. There needs to be long-term strategies that will take measured steps towards the solution. A starting point would be to identify areas of highest value and aggressively implement treatments on areas of greatest opportunity and where treatments have proven to be successful in the past.

Workshop VI – Synthesis

Moderator: **Linda Coates-Markle**

Strategic Planning: It's More Than Prioritizing

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In many cases land management decisions are jurisdictionally based and are a continuation of what has "always" been done. When faced with an ever-changing environment and other adversities such as low staffing and budget constraints, decisions to continue in a steady state indefinitely may not be the best alternative for long-term successful management. Instead, basing land management decisions on strategic goals enables the land manager and organization to ultimately accomplish more.

Simply put, strategic planning determines where an organization is going over the next year or more, how it is going to get there, and how it will know if it gets there or not. Strategic planning can (and should) occur at many levels within an organization and can be most effective when done on a multi-jurisdictional level that incorporates land managers and property owners from all sectors of society. In the case of invasive species, developing a multi-jurisdictional strategic plan for eradication, control and management can useful in achieving the long-term desired results.

In response to the escalating number of acres being infested in southern Arizona by buffelgrass (*Pennisetum ciliare*), a group of federal and state agency representatives, county and city leaders, university researchers, and staff from non-profit organizations formed a coalition in 2006 to improve buffelgrass management across jurisdictions. This collaborative working group set out to achieve better coordination of treatment prioritization and community engagement by the development of a Southern Arizona Buffelgrass Strategic Plan. Twelve management goals were identified that would implement five key strategies:

- Minimizing buffelgrass spread
- Implementing control based on potential impacts
- Restoring treated areas in ways that increase resilience against future invasions
- Mitigating wildfire risks where control is no longer feasible
- Motivating legislation

As actions are undertaken and goals are accomplished, the Strategic Plan will be modified and adjusted to address the most important needs identified by the working group members. This process has resulted in proactive buffelgrass management and a lively engagement from all sectors of the community.

Poster Session Abstracts

Post-Fire Plant Recovery in the Mojave and Sonoran Deserts of Western North America

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I systematically reviewed published literature that reported data on plant community recovery after fire in the Mojave or Sonoran Deserts. Re-sprouting by desert perennial species is generally limited but varies among species. For example, two studies found that an average of 75% of burned *Yucca schidigera* re-sprouted, whereas *Larrea tridentata* re-sprouting ranged from 3-37% among five studies. In chronosequence and permanent plot studies of community recovery, only weak trends were evident that species composition on burns was converging with unburned areas. For instance, time since fire explained only 9-19% of the variance in the Sørensen similarity of burned and unburned composition in studies with measurements up to 47 years after fire. In contrast, perennial plant cover and time since fire were closely related (r^2 = 0.39-0.99), suggesting that perennial cover recovers more rapidly than composition. Based on ordinating data from 13 studies, overall perennial composition after fire differs between the Mojave and Sonoran Deserts. Dominant post-burn species variously included *Ambrosia deltoidea*, *Ephedra nevadensis*, *Gutierrezia sarothrae*, *Encelia virginensis*, *Sphaeralcea ambigua*, and grasses like *Achnatherum speciosum*. Some species exhibited versatility by being dominants in both burned and unburned habitat (e.g., *A. deltoidea*, *E. nevadensis*), at least in terms of their relative importance within communities even if their raw abundance declined after fire. While some general principles are suggested by analyzing the available literature as a whole, results suggest that more work is required for improving specific knowledge about plant recovery among fires, sites, species, and climates.

Early Post-Fire Succession on a Heavily Visited Mojave Desert Burn: Red Rock Canyon near Las Vegas, Nevada

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We examined plant recovery, soils, and soil seed banks on the 348-ha, 2005 Loop Fire in Red Rock Canyon National Conservation Area, 15 km west of metropolitan Las Vegas, Nevada. This burn is of special concern to resource managers because more than 900,000 people visit a scenic Loop Drive encompassed by the burn. We conducted sampling two years after the fire by measuring 10, 0.01-ha plots on the burn and on a paired unburned area. Perennial species composition shifted from dominance by late-successional native shrubs (e.g., blackbrush) on the unburned area to native perennial forbs (e.g., globemallow, desert marigold) on the burn. The burn was more species-rich, with richness of live plants averaging 26 (100 m^2 scale) and 239% (1 m^2 scale) greater. Fire and microsite (interspace, below creosote or yucca) interacted to affect 0-5 cm soil properties, with higher pH, conductivity, and total P and K on burned yucca microsites. Red brome density in 0-5 cm soil seed banks was four times lower on the burn, and its distribution among microsites reversed. Below-shrub microsites contained the most brome seeds on the unburned area but the least on the burned area. Intense fire below shrubs may have increased seed mortality, an idea supported by > 3-fold decreases we found in emergence density after experimentally heating seed bank samples to 100°C. Our study occurred after a post-fire period of below-average precipitation, underscoring a need for continued monitoring that characterizes moister years and evaluates aesthetic recovery on this heavily visited burn.

Management Techniques for the Control of Sahara Mustard (*Brassica tournefortii*) in the Mojave Desert

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In the southwestern United States, *Brassica tournefortii* (Sahara mustard) is a highly invasive plant that colonizes roadsides, beaches, sand dunes, and open desert threatening native annuals. Sahara mustard is believed to contribute to fuel loads in the Mojave Desert in areas where *Schismus* sp. and *Bromus* sp. occur. Sahara mustard may act as ladder fuel, thereby facilitating the spread of fire throughout the landscape. Manpower limitations and insufficient funding limits land managers ability to effectively control Sahara mustard. We tested seed germinability in Sahara mustard after fruiting plants were treated with either 2%, 5%, or 12% triclopyr. Sahara mustard seed pods were labeled based on three developmental stages prior to treatment. Application of herbicide decreased germination from control seeds, however effectiveness did not differ across concentrations of triclopyr (2, 5, and 12%). We also tested seed germinability in Sahara mustard after fruiting plants were separated from their resources and allowed to dry in the field. Seed pods were labeled by developmental stage before treatment. The three treatments consisted of; 1) pulling plants with roots intact; 2) pulling the plant and breaking the roots and leaf rosette from the inflorescence; 3) pulling off individual fruits. All treatments resulted in a decrease in germination from control seeds.

Monitoring Cheatgrass Invasion in Northeast Nevada with Aerial Photography

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Cheatgrass (*Bromus tectorum* L.) is a non-native annual grass that invades sagebrush communities and outcompetes many native grasses, partly by low-temperature growth. Cheatgrass matures earlier than native grasses and is highly flammable after senescence. If unchecked, cheatgrass production puts the sagebrush community at increased risk of fire. Once burned, sagebrush recovery is impeded by little, if any, sagebrush recruitment and by increased fire frequency. Cheatgrass-dominated rangeland is very difficult to return to native composition. Intervention with control efforts prior to cheatgrass dominating the herbaceous component of a sagebrush community could allow avoidance of this transition. Satellite and small scale aerial imagery can only pick up cheatgrass once it has reached dangerously-large population levels where control measures may be infeasible. In this study we compared aerial and ground images to satellite and field-gathered data from northeast Nevada to determine the efficacy of Very Large Scale Aerial (VLSA) imagery for detecting cheatgrass. VLSA imagery captured low-level cheatgrass infestations; cheatgrass cover data measured from VLSA imagery was comparable to that measured from ground imagery or with a laser point-frame, but not with a satellite-based predictive map. We tested the utility of VLSA-derived cheatgrass cover data by spatial analysis which confirmed the known cheatgrass preferential colonization of south-facing slopes and of burned sites. VLSA imagery is a means for detecting low-level cheatgrass infestations across vast acreages of rangeland and can be effectively used to monitor rangelands for cheatgrass more accurately than with satellite imagery, a more economically than with ground surveys.

Vulnerability of the Rarest Plants in the Great Basin of Nevada to Climate Change

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Pollen, woodrat midden, tree-ring, and lake level data over the past 50,000 years show the Great Basin is a highly sensitive indicator of climatic change. Endemic plant species are expected to be at far greater risk of extinction from climate change. We assessed vulnerability of the rarest endemic plants of the Great Basin of Nevada based on their reported elevation ranges. Our assumption is that those narrow endemic plants with the most restricted elevation range are likely to be among the most vulnerable. The results show that the rarest plants in the study area typically occur within less than a 500-foot elevation range in highly specialized habitats on the valley floors. The general lack of suitable habitats above the valley floors increases their vulnerability as upward migration is precluded. Moreover, the valley floor habitats are also more susceptible to other stressors such as habitat modification or destruction and invasive species. The restriction of these plants to specialized habitats may also constrain or preclude such mitigation options as assisted colonization. An integrated and comprehensive program of seed collection and ex-situ storage is urgently needed to ensure that a full range of genetic diversity is available for future conservation options.

Prescribed-Fire and Environmental Effects on Cattle Distribution Patterns Within Sagebrush Steppe Rangelands

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Remnants of the sagebrush steppe ecosystem currently occupy about 25 million acres of the western U.S. Cattle-grazing is a principal use of sagebrush steppe rangelands. Prescribed fire is increasingly being used to maintain or improve the ecological condition of these rangelands. We have only a very limited understanding, however, of the interactive effects of prescribed-fire treatments and environmental factors on cattle distribution and activity patterns within sagebrush steppe rangelands. GPS tracking collars were used to evaluate spatio-temporal responses of mature beef cows to two fall, prescribed-fire treatments; Breaks (9/23/2002) and Whiskey Hill (9/27/2004) fires, in the Owyhee Mountains of southwestern Idaho. Cattle locations were recorded for 2 years prior to each fire and at least 4 years post fire. Cattle grazing the Breaks study area in July exhibited no selectivity for the burned area prior to the burn but selectively occupied the burn for 3 of 4 post-fire years. Pre-fire cattle use of near-stream (< 20m) habitats was 1.5 to nearly 2.5 times availability. Post-fire use was more variable. Near-stream use one year post-fire was similar to pre-fire use. Cattle then slightly avoided near-stream habitats during the second year following fire. These habitats were again highly selected 3 and 5 years post-fire. Cattle traveled farther (35.8 m/10-min observation interval) during the first year post-fire than any other year of the study. Initial analyses indicate cattle grazing the Whiskey Hill study area in May continued to exhibit very high selectively for the burned area even 4 years post-fire.

Big Sagebrush Seed Bank Densities Following Wildfires

Charlie D. Clements, **Dan. N. Harmon** and **James A. Young**

Big sagebrush (*Artemisia* spp.) is a critical shrub to such sagebrush obligate species as sage grouse, (*Centocercus urophasianus*), mule deer (*Odocoileus hemionus*), and pygmy rabbit (*Brachylagus idahoensis*). Big sagebrush do not sprout after wildfires and big sagebrush seed is generally short-lived and do not survive wildfires (Young and Evans 1989). In recent years land managers have brought to our attention that they have been informed that big sagebrush does build persistent seed banks and that these seed banks have the potential to re-establish big sagebrush back into burned habitats. Young and Evans (1989) also reported that they found no mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) or Basin big sagebrush (*Artemisia tridentate* ssp. *tridentata*) emerged from germination tests of 1,000 soil surface samples from burned habitats. We tested any possible seed bank potential of mountain big sagebrush and Wyoming big sagebrush (*Artemisia tridentate* ssp. *wyomingensis*) following wildfires at two separate sites in western Nevada. We established fifty-four 3m plots on the south as well as the north edge of the fire line for both locations. Plots were established at 1m, 10m, and 30m from the fire edge in the burned soil and soil bioassays were collected and returned to the greenhouse to undergo germination of seed bank densities. Bioassays were conducted in mid September following the August wildfires and again in late February after seed set. Adjacent 3m plots were also established and seeded at a rate of 45g/ha rate to record any differences in big sagebrush establishment when seeded versus not seeded. We found no evidence that Wyoming big sagebrush seeds survived the wildfire event in our bioassay efforts and no seedlings were recorded (from natural seed dispersal) at our 1m, 10m, and 30m plots that were unseeded. We did experience the recruitment of seedlings (1/plot) in 3 of the seeded plots. Our mountain big sagebrush site yielded evidence of an active seed bank following the wildfire. The south edge of the wildfire average 1.8, 6.7, and 1.8 seeds per plot in the 1m, 10m, and 30m plots, respectively. The north edge recorded an active seed bank in the 1m plot, averaging 1.8/plot. We also recorded the recruitment of sagebrush seedlings in 7 of the seeded plots, averaging 1.3/plot. Wyoming big sagebrush sites are more xeric and much more difficult when it comes to restoring these communities following devastating wildfires. Our data, along with much of the literature, recommends that Wyoming big sagebrush requires seeding or transplanting efforts in its restoration process. Mountain big sagebrush communities receive more favorable precipitation and thus the communities have a greater potential to re-establish on their own. The data that we have collected suggests that mountain big sagebrush has a greater potential of restoring itself due to this active seed bank than some of the past literature suggests, nonetheless, this restoration process varies by site and to get back to pre-burn densities may very well be longer than that of most resource managers entire career.

Implications for Management Prioritization of Exotic Annual Weed Monitoring Near Roadsides in the Eastern Mojave Desert, USA

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Invasive exotic plants provide an unnatural conduit for fires in the Mojave Desert. Our study examines site conditions that may facilitate invasion by these plants. We evaluated 12 sampling plots within Lake Mead National Recreation Area and adjacent public lands to determine trends in microsite invasibility dependent upon distance from road and microsite types (i.e. under canopies of *Larrea tridentata* and *Ambrosia dumosa* along with shrub interspaces). Microsites were sampled for exotic annual plant community composition and cover over a 45-m gradient from each roadside. Six exotic species were detected throughout sampling. *Schismus* spp. were the most frequently encountered exotic annual followed by *Erodium cicutarium* and *Brassica tournefortii*. An overall distance effect was significant for exotic cover ($p = 0.0145$); however, exotic cover did not systematically decline with increasing distance. Microsite differences had the strongest effect ($p = 0.0002$) with shrub microsites having higher exotic cover than interspaces. Species such as *Bromus rubens* and *Brassica tournefortii*, which are known to create significant fuel loads, were found predominantly in the shrub microsites. Disturbance and microsite conditions may be more likely to explain exotic species distributions than distance from road corridors. Understanding how these site characteristics play a role in exotic annual species distributions will help managers prioritize areas for monitoring and treatment options.

The Combined Effects of Harvesting and Burning on Nutrient Budgets in a Sierran Forest

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Carbon and nutrient removals by two methods of thinning (whole-tree and bole only) and subsequent prescribed fire (in both thinned and unthinned plots) were estimated for Jeffery pine forest in the eastern Sierra Nevada mountains of California. Carbon and nutrient exports were greater in plots that had been thinned and burned than in plots that were burned only, but differences were statistically significant only in the cases of C, P, K, and not for N, S, or Ca. The combined effects of thinning and burning on C and N removals were approximately equal for the two harvesting methods even though harvesting dominated exports in the whole-tree thinning treatment and burning dominated exports in the bole only thinning treatment. Harvesting dominated the total removals of P, K, Ca, Mg and S in the whole-tree thinning treatment, and total removals of P and K were significantly greater in the whole-tree thinning than in the bole only thinning treatment. In the bole only thinning treatment, burning dominated total removals of P, K, Ca, and S. Comparisons of nutrient removals with ecosystem capital and calculations of potential replenishment by atmospheric deposition suggested that N is the nutrient likely to be most depleted by harvesting and burning treatments.

Seeding Effectiveness for Eight Mojave Desert Perennial Species After a 2005 Wildfire

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In the Mojave Desert, where germination is largely dependant on the timing and amount of precipitation, seeding is a risky endeavor, but it is one of a limited number of restoration techniques available to managers attempting emergency revegetation on large desert burns. We monitored the seeding success of eight perennial shrub species the 33,500-acre 2005 Goodsprings Fire within the Red Rock Canyon National Conservation Area in southern Nevada to evaluate the effectiveness of seeding for accelerating revegetation two seasons after the aerial application of seeds. Seeded species consist of a mix of native perennial forbs, grasses, and shrubs. The seeding was divided into six plots totaling over 2700 acres that span different topographical features, soil types, and unburned plant communities. To date, seeding has not statistically affected the abundance of seeded species, although there are trends indicating that *Atriplex canescens* and *Sphaeralcea ambigua* may increase in abundance with seeding. Greenhouse seed bank trials produced no seedlings of seeded species in seeded or unseeded plots. The extraction method for seed isolation from the soil detected the presence of some of the seeded species, but in low abundance, and with no difference between seeded and unseeded plots. Many factors could affect seeding success including soil moisture availability, granivory, and use of species appropriate for existing site conditions and successional stage. We looked at the seeded species and associated plant communities coupled with the natural environmental variation across seeded plots to interpret the observed responses.

Vegetation Reestablishment of Mojave Desert Plant Communities After 2005-2006 Wildland Fires

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During 2005 above average precipitation from the previous winter and spring led to increased vegetative production, particularly for annual species including exotic invasive grasses. This biomass readily carried wildland fires. The result was over 125 fires greater than 5 acres in size in Clark Co., NV alone in 2005 and 2006. During winter 2007 and spring 2008 we sampled plant community composition in 15 burns and adjacent unburned unburned sites from 2005-2006 burns in Mojave desert shrubland. We quantified the cover of perennial species and related their presence and abundance to abiotic site characteristics, soil chemistry, and unburned plant community composition to examine factors affecting vegetative recovery. After two growing seasons burned plots were dominated by the early successional perennial species *Dasyochloa pulchella, Encelia virgensis, Pleuraphis rigida,*and *Sphaeralcea ambigua,* in contrast to the unburned communities dominated by *Larrea tridentata, Ambrosia dumosa,* and *Coleogyne ramosissima.* The density of exotic *Bromus rubens* remained strongly reduced by the burn (1.9 ± 0.6 percent cover in burned plots, 14.0 ± 1.9 in unburned communities.) Elevation and latitude were correlated with burned community composition. Additionally, unburned plant community composition did not determine the recovery rate on burned plots and the similarity between burned and unburned plots was not associated with initial plant community or soil type. Burned plant community composition was associated with soil texture and total soil nitrogen; unburned plant communities were more closely associated with specific soil micronutrients. Understanding the process of post-fire recovery in an increasingly fire-rich landscape will help managers design effective restoration strategies.

Effectiveness of Imazapic Herbicide in Reducing Post-Fire Cheatgrass Invasion in Zion National Park

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The Dakota Hill Complex Fires burned approximately 2400 hectares in Zion National Park during July of 2007. In response to the fires, a Burned Area Emergency Rehabilitation (BAER) Team recommended a landscape level application of imazapic (tradename Plateau®) herbicide to reduce cheatgrass (*Bromus tectorum)* occurrence in the Park. Approximately 1273 hectares of the high severity burned landscape were sprayed by helicopter during September of 2007. The implications of such a large scale application of imazapic herbicide to burned landscapes are not fully understood. Thus, this project monitors the effectiveness of this landscape scale application of imazapic in suppressing the post-fire invasion of cheatgrass over three years. Effects of the herbicide on the native understory plant community are also being evaluated to discern any negative impacts. Additionally, the viability of cheatgrass one season post-application was assessed, as the treatment would be considered ineffective if the biomass of individual cheatgrass plants is reduced but the seed production and viability remained constant. The monitoring is being conducted using a paired plot study (treated and untreated) in both piñon-juniper (*Pinus-Juniperus spp.)* and Gamble oak (*Quercus gambelii)* vegetation types. Density, cover, and biomass were measured by species to discover the effect of the herbicide on the understory plant community. Cheatgrass viability was evaluated through germination tests in a germination chamber. Preliminary results imply that the herbicide application is reducing occurrence of natives, as well as increasing cheatgrass viability. Thus, we could be eliminating the advantage of any initial post fire cheatgrass reduction by imazapic.

Facilitation in the Sagebrush Steppe: The Role of *Lupinus argenteus* in Seedling Establishment and Invasion

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Organization within a community is a function of the combined positive and negative interactions among species. These interactions are particularly important for seedling establishment, which is limited not only by the availability of propagules, but also the availability of safe sites and resources. We examined the possible facilitation of seedling establishment by a native legume, *Lupinus argenteus* in intact and burned sagebrush steppe. A field experiment was set up with six treatments chosen to identify mechanisms by which *L. argenteus* may influence establishment: 1) live lupine, 2) dead lupine, 3) no lupine, 4) no lupine with lupine litter, 5) no lupine with inert litter, and 6) mock lupine. Environmental variables (nitrogen availability, soil moisture, temperature, and light) were assessed and seedling establishment of the native grass *Elymus multisetus,* the exotic grass *Bromus tectorum*, and the native perennial forb *Erioginum umbulatum* were monitored. In both intact and burned communities *B. tectorum* had higher germination and seedling survival than either native species. In intact communities, increased N availability from lupine litter increased *B.tectorum* survival, but survival of native species was unaffected by lupine treatment. In contrast, in burned communities, reduced light and temperature fluctuation in litter treatments facilitated *E. multicetus* survival whereas *B. tectorum* was unaffected by treatments. These results suggest that facilitation is a dominant factor influencing community dynamics in the sagebrush steppe, but the exact mechanism differs depending on species origin and life form.

The Effects of Slash Pile Burning on the Soils of Little Valley, NV

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Prescribed fires, including slash pile burning, are both criticized and praised as a forest management technique. When slash piles are used as a prescribed fire technique, concerns arise over the effects of prolonged, severe burning on soil fertility and water quality. This study examines nutrient concentrations including ammonium, nitrate, total nitrogen, total carbon, magnesium, iron, calcium, sodium and phosphorous in soils, runoff solution, snowmelt and soil solution. These were monitored using runoff collectors, tube lysimeters, resin lysimeters, resin stakes and soil samples. Initial results have shown significant nutrient differences between points in the piles and control areas.

Assessing the Successful Establishment of Post-Fire Seeding in the Great Basin: A Focus on Elko County, Nevada

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The shift of Great Basin ecosystems from diverse shrub-grass communities to near monocultures of annual grasses has severely modified their structure and function, causing more frequent and intense fires. The Bureau of Land Management (BLM) in Nevada currently spends millions of dollars each year to re-seed land affected by fire, in an attempt to maintain diverse, productive communities for wildlife and grazing animal use. Seeds used for re-vegetation face many barriers that prevent their successful establishment in this semi-arid environment including rainfall and temperature variation, competition with invasive species, and soil condition. We investigated the successful establishment of seeded species in five fires that burned in 2006 in Elko County, Nevada, comparing establishment on flat areas, north facing slopes, and south facing slopes. Monitoring of the density of cheatgrass, seeded species, and residual, native grasses was conducted in 2007 and 2008. Sites varied considerably in their response to fire overtime; at some sites there were low densities of seeded, perennial grasses and increased densities of cheatgrass , while other sites showed greater densities of residual, perennial grasses. In general, we found the highest densities of seeded perennial grasses on flat areas, higher densities of residual, perennial grasses on north slopes, and the highest densities of cheatgrass on south slopes. Additionally, we found high densities of cheatgrass within the drill rows themselves on sites of all aspects. Drill seeding may be the most cost effective and efficient when seeding efforts are concentrated on flat areas and south facing slopes.

Competition Between Native Grass Seedlings and Cheatgrass: Can We Improve Restoration Success?

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Post-fire seeding takes place on a very large scale in the Great Basin, with millions of acres of seeding taking place after severe fire years. However, the success of these seedings is highly variable. A large part of the variability in seeding success is certainly due to year-to-year climatic variations and site-to site variation in the presence of competitive invasive species. However, post-fire seeding may be improved by tailoring restoration materials to specific site conditions. Specifically, we may see greater post-fire restoration success if seed materials are created that are particularly competitive with cheatgrass, a very common post-fire invader in cold desert systems. Research in my lab focuses on quantifying the competitive ability of remnant native perennial grasses in cheatgrass invaded sites, and we are trying to determine what traits make native perennials most competitive with cheatgrass. Studies have focused on big squirreltail (*Elymus multisetus*) collected from invaded and uninvaded locations in the sagebrush steppe. Some individual plants are better at competing with cheatgrass than others, and to-date, the traits that we have identified as potentially adaptive include: early timing of resprouting in the late fall (for adult squirreltail plants) and increased root to shoot ratios for seedlings. Here we present our methodologies and results, and encourage restoration material developers to consider releasing native plant materials with traits that confer a stronger chance of establishing in highly disturbed and cheatgrass-invaded systems.

Effects of *Bromus tectorum* Invasion on Seedling Establishment Processes in Sagebrush Steppe Ecosystems

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The rapid spread of *Bromus tectorum* L. (cheatgrass), an annual Eurasian grass, into sagebrush-steppe is one of the most significant invasions in western North America. Initial invasion of *B. tectorum* is often facilitated by overgrazing. Once established, this invasive grass promotes ecosystem changes that affect establishment of native species. This study examined factors that influence ecosystem resistance to invasion by *B. tectorum* and resilience following disturbance in sagebrush-steppe. We evaluated differences in resource availability and seedling establishment of *B. tectorum* and *Elymus multisetus*, a native perennial grass, in an intact sagebrush-steppe ecosystem with a perennial grass understory, and an adjacent disturbed sagebrush ecosystem with a *B. tectorum* understory. Within each community we examined four microsites: under shrub; shrub removal; interspace with herbaceous cover and bare-ground interspace. *Elymus multisetus* establishment was higher in bare-interspaces and undershrub microsites, but overall seedling survival was lower in the invaded than the native community. *Bromus tectorum* establishment, biomass and seed production were lowest in interspaces dominated by perennial bunchgrasses and highest in microsites previously occupied by the invasive grass. In native communities, invasibility appears to be positively related to increases in resource availability and negatively related to the abundance and cover of perennial bunchgrasses. Our results suggest that perennial bunchgrasses confer resistance to invasion mainly through resource sequestration and occupation of physical space. In the invaded community *B. tectorum* appears to create feedback mechanisms that facilitate its own establishment while reducing the likehood of *E. multisetus* establishment and decreasing restoration potential.

Improving the Science Literacy of Audiences through Visual Communication

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Communicating science effectively to diverse audiences including natural resource managers, policy makers, and the general public, has broad implications for implementing science-based solutions to environmental problems such as those associated with non-native species invasions. If audiences are able to understand and assess scientific information, they are more likely to make decisions based on facts rather than on hearsay or speculation. Frequently, popular press articles on invasive species are designed to promote fear-based responses. Previous work in an ecological publication identified that even invasion biologists use militaristic and combative language as metaphors, often leading to an inaccurate perception of invasive species and loss of scientific credibility, which can be counterproductive to achieving conservation and management goals. Scientists and educators are natural collaborators to increase the science literacy about the biology and ecology of non-native species invasions to audiences, while consistently maintaining scientific integrity and credibility. Further, as increasing numbers of research granting entities require an outreach and education component in project proposals and outputs, proven ability to effectively present and disseminate scientific information to diverse audiences is becoming highly valued. This poster presents examples of how visual design strategies and learning theory can be used to engage audiences and communicate science effectively.

Effects on Native Plant Regeneration and Understory Plant Community Response Following Post-Fire Rehabilitation with Seeding in the Warm Fire

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On June 8th, 2006, a lightning strike ignited the Warm Fire on the northeastern edge of the Kaibab Plateau in Northern Arizona. The fire was managed first as a Wildland Fire Use (WFU) fire and then as a wildland fire and was one of the most substantial fires to burn in the Southwest in recent history. The fire has caused a tremendous amount of controversy about the WFU program and management decisions made by the Kaibab National Forest and specifically for our study, the decision to aerially seed the wildland fire portion with a non-native grass (*Lolium multiflorum*). Forest managers often employ restoration activities like re-seeding to control erosion for community protection and ecological health, however the long term implications of this practice have been minimally studied. Through the partnership with Grand Canyon Trust, Northern Arizona University and the Forest Service, we have completed two seasons of data collection with a total of 100 plots spread throughout the high severity portions of both the wildland and WFU sections of the fire, low severity areas and controls outside the burn. This research characterized understory vegetation response to fire and assessed potential plant community composition differences across the ponderosa pine forests in the Warm Fire. This poster will provide an overview of the project, the results of data currently being analyzed and the implications for future management decisions.

Recent Wildfire Impacts on the Threatened Lahontan Cutthroat Trout

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Changing climate has affected summer temperatures and the timing of spring snowmelt which has contributed to increasing the length of the wildfire season, wildfire frequency, and the size of wildfires (McKenzie *et al*. 2004, pp. 893-897; Westerling *et al*. 2006, p. 941). Westerling *et al.* (2006, p. 942) conclude that there are robust statistical associations between wildfire and climate in the western United States and that increased fire activity over recent decades reflects responses to climate change.

Studies have shown that post fire hydrologic events can severely reduce or extirpate local fish populations (Novak and White 1990, pp. 122-123; Propst *et al*. 1992, p. 120; Bozek and Young 1994, p. 92; Rinne 1996, p. 654; Rieman *et al*. 1997, pp. 50-53). Recolonization rates depend on the proximity and relative location of refugia, access from refugia to disturbed areas (*i.e*., no fish barriers), and the occurrence of complex life history traits and overlapping generations (Gresswell 1999, p. 210; Dunham *et al*. 2003b, pp. 185-186; Howell 2006, pp. 990-993). Isolated fish populations are at a much higher risk of extinction because they cannot recolonize after a large disturbance (Rinne 1996, p. 656; Dunham *et al*. 1997, p. 1,131). Additionally, effects on small headwater streams are more severe because entire drainages are burned at these smaller spatial scales, in contrast to larger stream orders, where relatively small proportions of the drainage burn. Numerous LCT streams have been burned in the last decade, and while no extirpations have been recorded, reductions in population size have occurred.

Although LCT evolved in a fire prone environment, increases in wildfire frequency and severity due to increased fuel loads and effects from climate change (Westerling *et al*. 2006, p. 941) have increased the threats due to wildfire. Current wildfires are a larger threat to LCT because of existing habitat loss and the current fragmented and isolated state of occupied habitat. LCT populations in the South Fork Little Humboldt River, Rock Creek, Maggie Creek, Quinn River, Truckee River and Walker River have recently been impacted by wildfires and/or fire suppression tactics. We conclude that wildfire is a significant threat to LCT throughout its range.

Post-Fire Monitoring of Soil Stability and Dust Emission on the Milford Flat Fire, West-Central Utah

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Soil stabilization is a major objective of post-fire emergency stabilization and rehabilitation (ES&R) projects, yet monitoring data are rarely sufficient to determine whether treatments are effective in achieving this objective. To address this need for information, the U.S. Geological Survey and Bureau of Land Management are collaborating on a project to monitor effects of ES&R treatments on soil-surface stability and rates of dust emission in low-elevation portions (< 1500 m elevation, 150-200 mm precipitation) of the 147,000-ha Milford Flat Fire that occurred in west-central Utah in July 2007. In August 2008, 24 monitoring plots were established to evaluate the effectiveness of three types of ES&R treatments (aerial seeding and chaining, seeding with a rangeland drill, and seeding with a rangeland drill after herbicide application) on two different substrates (fine loamy vs. sandy). Plots are concentrated in areas where field observations and satellite imagery indicated high rates of dust emission during spring 2008. Monitoring attributes include indicators of erosion resistance (soil aggregate stability, ground cover, and the size distribution of gaps between plant canopies) in addition to standard measures of plant cover and community composition. Seasonal rates of dust emission are currently monitored with BSNE dust samplers. Post-treatment sampling in August 2008 indicated that average soil-surface stability was highest in unburned control plots and in burned plots that were not treated. Average soil stability was lowest in burned plots that were seeded with a rangeland drill following herbicide application. The first set of dust-emission data will be collected in November 2008.

Post-Wildfire Seeding in Forests on Federal Lands: Trends, Costs, Effectiveness, and Use of Native Seed

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Since publication of recent post-fire seeding reviews (2000-2004), several important developments have altered the context of post-wildfire seeding and spurred an increase in research on seeding effectiveness and agency monitoring of post-fire treatments. By following the methodology of a systematic review we are developing a practical, thorough, and up-to-date synthesis of the latest information on post-wildfire seeding. Topics which will be analyzed related to seeding are: (1) trends in seeding over time: changes in area and amounts of seed used, seed sources, and species selected; (2) cost per acre seeded, costs associated with alternative seeding technologies, cost-benefit analyses; (3) effects: effectiveness of seeding for soil stabilization control and invasive species control, measures of success, monitoring projects, effects of seeding vs. natural regeneration; (4) native seeds: native species sources, costs, and effectiveness. This synthesis focuses on forested Federal lands primarily within the western U.S. Data sources include publications from scientific journals, "gray" literature, unpublished theses, and management reports. Burn Area Emergency Rehabilitation (BAER) reports and related post-fire monitoring documents are being evaluated to provide the best overview of current seeding practices, costs, and changes over time. The literature is being synthesized with a systematic review, a rigorous, predetermined protocol to ensure that the synthesis is thorough and unbiased. Thus, this synthesis of post-wildfire seeding information will be a complete and reliable review which will be helpful for land managers across the U.S.

Modeling the Effects of Nitrogen Deposition, Precipitation Variability, and Soil Texture on Winter Annual Production and Fire Risk in the Desert

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Fire risk in deserts is increased by high production of annual grasses and forbs that create continuous fine fuel between shrubs. Interspace production is influenced by many factors including water and N availability and soil texture, so the DayCent model was used to investigate how production of herbaceous annuals changes along gradients of these production-forcing factors. DayCent was calibrated and validated on the interspace vegetation from creosotebush scrub and piñon-juniper woodland in Joshua Tree National Park. The DayCent model was well calibrated in both vegetation types, but validation showed that the model is sensitive to soil clay content; soils with low clay contents are low in total C and N, most likely due to soil rapid drying and decreasing both production and mineralization. Despite discrepancies between modeled and observed soil C and N pools, relative response of production to N fertilization was well modeled indicating that DayCent can be used for conservative estimates of fire risk under increased precipitation and N deposition. Fire risk simulations show that interspace vegetation is strongly limited by water availability when mean annual precipitation is less than 21 cm yr^{-1}. Under simulated N deposition of 8 kg-N ha^{-1} and 14 cm of precipitation in creosotebush scrub, approximating the most polluted regions in the western Sonoran Desert, the risk of exceeding the fire threshold of 1 t ha^{-1} of fine fuel is between 55-65% under a range of soil textures. This indicates fire risk is high under increased N deposition in years of average to above-average rainfall. If policy actions resulted in a 50% reduction in N deposition, fire risk would drop to 17-35%, indicating that deposition reductions would have a substantial effect on fire risk and demonstrating the utility of this model in evaluating critical N deposition loads for fire in the desert.

SageSTEP: Evaluating the Effects of Fire and Fire Surrogate Treatments in Sagebrush Communities of the Great Basin

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. Many remaining sagebrush communities are in poor health, with a preponderance of old shrubs and a scarcity of native plants in the understory. The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) is a 5-year study that will explore ways to restore sagebrush communities. 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 will provide resource managers with information that can reduce the risk and uncertainty of restoration decisions. This poster outlines study design and objectives, implementation of experimental treatments, data collection and preliminary observations, and discusses how information is being disseminated through academic, agency, and public channels.

Reducing Fuel Load of Key Cheatgrass [*Bromus tectorum* L.] Dominated Range Sites by the Use of Fall Cattle Grazing

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Reducing cheatgrass fuels using spring cattle grazing techniques is impractical on scales large enough or concentrated enough to be effective. However, cattle can be concentrated on cheatgrass during the fall, effectively reduce the amount of total fuel available during the next fire season. The overall goal of the project is to investigate the efficacy of fall grazing of cheatgrass by cattle, on a ranch scale, as a fuel reduction tool, without affecting the cattle's performance, or harming the perennial plants present. The project is located on the University of Nevada Reno Gund ranch 50 miles northeast of Austin on 6.1 km^2 (1500 acres). Fall grazing removed significant amounts of cheatgrass forage during both 2007 and 2008. Cattle preferred cheatgrass over perennials as illustrated by their removing 78.5% of Cheatgrass by weight and 60.5% of the perennial grasses over the two year study period. After the second fall grazing period, Cheatgrass density , cover and litter declined significantly, whereas perennial density and cover were unaffected. Cheatgrass seed density was significantly higher in 2007 grazed than control and reversed in 2008 being significantly lower in grazed versus control. Cattle gained 1.2 and 1.75 pounds per head per day in 2007 & 2008 respectively, and gained one quarter of a body condition score each year. Fall grazing ranch scale tracts with cattle for the purpose of cheatgrass fuel removal is a valid management option. Yearly production and nutritional content are important to know before grazing.

Seed Removal by Granivores in Burned Mojave Desert Habitat: Implications for Revegetation

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Increased abundance of exotic annual grasses provide fuel for wildfires in North American desert habitats where fires were once uncommon events. Direct seeding techniques are used in an attempt to re-establish plant species important to desert ecosystem functions and processes. Granivorous ants and rodents are important components of North American deserts, and their seed-eating behavior can influence plant composition and establishment. Granivores can potentially consume large amounts of the seed used in re-vegetation, possibly slowing restoration efforts. To elucidate seed predation patterns by ants and rodents, we performed a seed removal experiment in burned and unburned creosote (*Larrea tridentata*) scrub desert habitats on the 2005 Goodsprings Fire in southern Nevada. We studied seed removal using wire cages that either excluded or included ant or rodent access to seeds. We offered 20 seeds of eight native species, and quantified seed removal by subtracting the number of seeds that remained in a Petri dish after a four day trial. Our results indicate that seed removal was three times higher in cages that allowed ant access in burned habitat, and seeds of *Penstemon bicolor*, *Encelia farinosa*, and *Sphaeralcea ambigua* suffered greater seed losses. Our results suggest that granivorous ants may play a significant role in the establishment of plant communities in burned areas by preferentially removing seeds of small seeded plant species. Therefore, managers may choose to sow species that are less susceptible to predation by ants in burned areas.

Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin

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As range, watershed and wildlife managers realize the magnitude of ecosystem change in the Great Basin, many proactive projects to improve resource sustainability, value, and productivity have been and are being planned and implemented. These include seedings, vegetation manipulation, noxious weed control, and post-wildfire stabilization and rehabilitation across a variety of ownerships. Faculty with the University of Nevada Cooperative Extension (UNCE) and Nevada Agricultural Experiment Station (NAES) in collaboration with the United States Geological Survey (USGS) Great Basin Integrated Landscape Monitoring Pilot Project, Nevada Department of Wildlife, and the Agricultural Research Service plan to collaboratively learn from these endeavors. Through monitoring vegetation and soil response together with land managers we can understand the consequences of management action and inaction; continue to refine project implementation tools; adapt management; and disseminate important and valuable information. By learning from current and historic management actions, and natural experiments (e.g., wildfire), we can collectively study many more treatments and actions than any scientist or team of scientists could afford to implement as experimental treatments. By building upon the foundation of historic monitoring and pre-project base-line data, we can document long term effects with replicates for statistical analyses. This project proposes to coordinate monitoring efforts and pool monitoring data across organizations and individuals because the sum is more valuable that the individual components. These monitoring data, once collected, analyzed and interpreted will improve our understanding of landscape-level ecological processes and our ability to manage and predict rangeland health and resiliency under a variety of natural disturbance and restoration regimes.

Effects of Summer Wildfires on Riparian Woody Species, Debris, and Channel Morphology in Northern Nevada

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Wildfire effects research emphasizes forested systems, yet in recent years in the Intermountain West most fire burns rangelands. Riparian areas and watershed effects have been a focus of management but have not been a focus research in this setting. This study compares channel morphology, bottom composition, woody species density, woody debris volumes, and other stream survey variables in riparian systems in the central and northern Great Basin. Forty-three perennial streams with pre-wildfire data that burned during the summers of 1999-2001 were re-surveyed during the summer of 2005. In the summer of 2006 forty-four perennial streams of similar geology, slopes and elevations and that had not burned in the past twenty-five years were re-sampled for comparison. Four to six years after wildfire, burned sites displayed elevated embeddedness, gravel, and sand/silt in the stream bottom with a corresponding decrease in cobbles compared to unburned sites. Also young riparian woody species were usually denser. Conversely differences could not be detected in bankfull width and depth, incisement width and depth, stream bottom boulder composition, woody debris volume, riparian vegetation rating, and bank cover ratings. Burned and unburned streams in the Great Basin seem to be resilient.

Effectiveness of Native Seeding and Landscape Scale Imazapic Applications for Controlling Cheatgrass in Zion NP

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The Kolob Fire started just outside Zion National Park in June 2006 and by the time of containment had burned 4256 hectares within the park. A Burned Area Emergency Rehabilitation (BAER) team was sent to evaluate the fire and formulate a rehabilitation plan. Pre-fire vegetation mapping of the park showed high amounts of cheatgrass (*Bromus tectorum)* and red brome (*Bromus* rubens) throughout the newly burned area. The primary concern of the BAER team was control of these invasive grasses due to their ability to dominate post-fire landscapes and the resulting shifts in fire regime caused by the creation of a continuous layer of fine fuels. The two treatments recommended by the BAER team were aerial application of imazapic herbicide (tradename Plateau™) complimented with a seed blend comprised of four native perennials. These treatments were implemented in late October 2006 and resulted in 200 hectares receiving seed and 3577 hectares of the burn being treated with imazapic. To our knowledge this is the first landscape-scale aerial application of herbicide to a post-fire environment within the Park Service. Three study sites were set up within the fire perimeter to evaluate the effectiveness of these treatments on the bromes and the residual plant community. At each site measures of plant density, cover, and biomass will be taken for five seasons along with additional measurements of soil nutrients, species richness and shrub density. This poster will show preliminary results from the first season of data collection.

Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants

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Volume 6 of the Rainbow series (Gen. Tech. Rep. RMRS-GTR-42-vol. 6.) is a state-of-knowledge review of information on relationships between wildland fire and nonnative invasive plants that can assist fire managers and other land managers concerned with prevention, detection, and eradication or control of nonnative invasive plants. The 16 chapters in this volume synthesize ecological and botanical principles regarding relationships between wildland fire and nonnative invasive plants, identify the nonnative invasive species currently of greatest concern in major bioregions of the United States, and describe emerging fire-invasive issues in each bioregion and throughout the nation. This volume can help increase understanding of plant invasions and fire and can be used in fire management and ecosystem-based management planning. The volume's first part summarizes fundamental concepts regarding fire effects on invasions by nonnative plants, effects of plant invasions on fuels and fire regimes, and use of fire to control plant invasions. The second part identifies the nonnative invasive species of greatest concern and synthesizes information on the three topics covered in part one for nonnative invasives in seven major bioregions of the United States: Northeast, Southeast, Central, Interior West, Southwest Coastal, Northwest Coastal (including Alaska), and Hawaiian Islands. The third part analyzes knowledge gaps regarding fire and nonnative invasive plants, synthesizes information on management questions (nonfire fuel treatments, postfire rehabilitation, and postfire monitoring), summarizes key concepts described throughout the volume, and discusses urgent management issues and research questions.

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