

Abstracts of the 64th Annual Meeting of the Society of Range Management, 2011, Billings, MT

Title Index - Click on title to view abstract

[89 Years of Photo Monitoring of Resources in the Gravelly Mountains of Southwest Montana](#)

*Arthur Hall**

[A Comparison of Stream Morphology and Vegetation of Cottonwood-Dominated and Open Reaches within a Riparian Ecological Site in NW Colorado](#)

Kira Puntenney, Emily Kachergis, Maria Fernandez-Gimenez*

[A Comparison of Vegetative Responses to Prescribed Fire in Grazed and Ungrazed Tobosagrass Flats in the Northern Chihuahuan Desert, Texas](#)

Laura A. Schnapp, Bonnie J. Warnock*

[A Conservation Partnership at Work in Western South Dakota](#)

*Matt Stoltenberg**

[A Focus on Lentic Riparian/Wetland Ecosystems](#)

*Lou Hagener**

[A Historical Perspective of Native Plants for the Restoration of Disturbed Landscapes](#)

John M. Englert, Jack R. Carlson, W. Curtis Sharp, Douglas Helms*

[A Historical Perspective on the Development of the Ecological Site Concept](#)

Joel Brown, Jack Alexander, Justin Derner*

[A Lifetime of Research and Observations Preserved: The August "Gus" Hormay Collection Available Online](#)

*Bonnie McCallum**

[A Matter of Ecological Context: The Response of Tallgrass Prairie Butterflies to Fire](#)

Ray Moranz, Diane Debinski, David Engle, Sam Fuhlendorf, James Miller*

[A Quantitative Protocol to Assess the Invasive Potential of a Plant Species into a Rangeland Ecosystem Using *Camelina sativa* \(Gold of Pleasure, Large-seeded False Flax\) as a Model](#)

Phillip Davis, Fabian Menalled, Bruce Maxwell*

[A Rangeland Hydrology and Erosion Model](#)

Mark Nearing, H. Wei, J.J. Stone, F.B. Pierson, K.E. Spaeth, M.A. Weltz, D.C. Flanagan, M. Hernandez*

[Ability to Extract Soil N at High Temperatures Allows Cheatgrass to Exclude Perennial Grasses](#)

A. Joshua Leffler, Thomas Monaco, Jeremy James*

[Aboriginal Burning and Keystone Predation: A New Paradigm for Range Management](#)

*Charles Kay**

[Accuracy of Cattle Grazing Distribution Patterns Recorded by Horseback Visual Observers During the Early Morning](#)

Steven Lunt, Derek Bailey, Adrienne Lipka, Milt Thomas, Morgan Russell*

[Agency Accomplishments - Making A Difference On-the-Ground](#)

*Linda Coates-Markle**

[Alberta's Wolf Report: Quantifying the Impacts](#)

*Callum Sears**

[Alfalfa Hay Supplementation Increases Ponderosa Pine Browsing by Goats in Winter](#)

Brent Roeder, Jeffrey Mosley, Rachel Frost, Tracy Mosley*

[Alternative Uses of CRP Lands: The Use of Livestock Grazing to Enhance Vegetation and Wildlife Biodiversity](#)

*Timothy DelCurto**

[Aminocyclopyrachlor: A New Herbicide for Pasture and Rangeland Weed Control](#)

Craig Alford, Jeff Meredith, Eric Castner, Michael Edwards, Susan Rick, James Harbour*

[An Algorithm for Approximate Rectification of Digital Aerial Images](#)

*Stephen K. Ndzeidze, Kipp E. Johnson, Michael D. Johnson, Mounir Louhaichi, Patrick E. Clark, Douglas E. Johnson**

An Assessment of Plant Community Structure, Herbivory, Soils, and State-and-Transition Theory on a Winterfat (*Krascheninnikovia lanata* [Pursh] A.D.J.Meeuse & Smit) Ecological Site

Casey Matney, Tamzen Stringham*

An Invasive Grass Alters Tallgrass Prairie Fuelbed Characteristics and Reduces Burn Probability

Devan McGranahan, David Engle*

An Overview of Lentic Wetlands

*Mary Manning**

An Overview of the Research and Studies on Diversifying Crested Wheatgrass Seedings

*Mike Pellant**

Analyzing the Effect of Slope Aspect and Phenology on Biomass Production in Western South Dakota Grasslands Using MODIS NDVI

Matthew Rigge, Alexander Smart, Bruce Wylie*

Applications of Molecular Tools for Rangeland Ecology and Management

Melanie Murphy, Chris Funk*

Applications to Current Monitoring Programs

*Gregg Simonds**

Arguments for a Major Research Focus on Seedling Establishment and Recruitment on Rangelands

*Tony Svejcar**

***Artemisia* Population Dynamics Under Different Climate Change Scenarios**

*Sarah Swope, Sabrina McCue**

Artificial Selection as a Tool to Develop Native Plant Materials for Novel Ecosystems

*Thomas Jones**

Assessing Climate Change Effects with Indicators for Rangeland Ecosystem Goods, Services and Core Processes

Kristie Maczko, Daniel W. McCollum, Jack A. Morgan, Clifford S. Duke, William E. Fox, Lori Hiding, Urs Kreuter, John E. Mitchell, John A. Tanaka*

Assessing Riparian and Aquatic Habitat Using Very-High Resolution Imagery

D. Terrance Booth, Samuel E. Cox*

Assessing Sagebrush Steppe Rangelands with VLSA Imagery

Corey Moffet, J. Bret Taylor, D. Terrance Booth*

Assessing the Success of the UtahPCD Watershed Restoration Initiative

*Curtis Warrick**

Assessment and Demonstration of Ecologically-Based Medusahead and Cheatgrass Management in Jordan Valley, Oregon

Edward Vasquez, Anna-Marie Chamberlain, Brenda Smith, Roger Sheley*

Attitudes and Perceptions on Fire Policy and Burn Bans in Texas; A Working Model for Meeting Today's Complex Fire Management Challenges

Mark Moseley, Brian Hays, Amy Hays*

Automated Generation of Very-High Resolution Orthomosaics and 3D Models in support of Fine Scale National Resource Applications

Matthew Bobo, Tom Noble*

Barriers to Collaborative Grazing Planning across Multiple Ownerships to Maintain Open Space and Wildlife Habitat in Washington Shrub-Steppe Ecosystems

*Tipton Hudson**

Benefits of Fence Marking for Sage-Grouse

Bryan Stevens, Kerry Reese, Jack Connelly*

Biological Assessment and Monitoring of Wetlands in the Prairie Pothole Region

*Christina Hargiss**

Bird Activities that Expand Existing Plant Community Ranges

Anne Bartuszevige*

Bison and Cattle: How Different Are They?

Brady Allred*, Samuel Fuhlendorf, Robert Hamilton

BLM and the Pollinator Partnership

Laurie Davies-Adams*, Carol Spurrier

BLM New Mexico: Fostering Successful Partnerships to Restore New Mexico's Enchanting Landscapes

Amelia Underwood*, Steven Torrez

Breeding Strategies for the Development of Bluebunch Wheatgrass for the Great Basin

Blair Waldron*, Steve Larson

Breeding Strategies for the Development of Native Grasses

Kevin Jensen*, Joseph Robins, Blair Waldron, Steve Larson

Bureau of Land Management, Wyoming - High Desert District, Rawlins Field Office, Sulphur Springs Allotment

Andy Warren*

"Burn early, burn often:" Contrasting Aboriginal Versus Modern North American Fire Management Regimes.

Cliff White*

Business Planning Concepts and Methods - How Does it Work?

Cindy Garretson-Weibel*

Can Targeted Sheep Grazing or Mowing Suppress Sulfur Cinquefoil (*Potentilla recta*) on Rangeland?

Rachel Frost*, Jeffrey Mosley, Brent Roeder, Rodney Kott, Duane Griffith

Capabilities, Challenges, and Cost of Using Unmanned Aerial Vehicles for Natural Resources Monitoring

Albert Rango*, Andrea Laliberte

Carbon Offsets for Utah Cattle Ranchers? Sequestration Potential of Deeded Lands and Implications for Policy and Management

D. Layne Coppock*, Zhao Ma, Thomas Monaco, Donald Snyder, Helga Van Miegroet, Grant Cardon

Cattle Grazing and Yosemite Toad (*Bufo canorus* Camp) Occupancy across a Hydrologic Gradient of Sierra Nevada Mountain Meadows

Leslie Roche*, Andrew Latimer, Danny Eastburn, Kenneth Tate

Change on the Range: Ten Years of Rangeland Monitoring on the Tonto National Forest

Jim Sprinkle*, George Ruyle, Michael Crimmins

Changes in Relic Plant Communities in Utah over 60 Years

Shane Green*, Keith Wadman

Changes of Some Elements in Soil of Three Species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of Enclosure in Rude Shur Saveh Rangelands

maryam saffariha*, hosein Azarnivand, ali tavili

Changes of Some Elements in Three Species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of Enclosure in Two Seasons (Summer and Autumn) in Rude Shur Saveh Rangelands

maryam saffariha*, hosein Azarnivand, ali tavili

Characterization of Forage Availability and Use by Feral Horses across Diverse Habitats in SW Alberta

Tisa Girard*, Edward Bork, Mike Alexander

Characterization of the Thermal Environment of Rangeland Pastures with Heterogeneous Vegetation Structure

Vanessa Prileson, Andres Cibils*, Wendy Taylor, Richard Dunlap, Shad Cox, Miguel Brizuela, Silvia Cid

Cheatgrass Biomass and Competition: Is a Greenhouse Fight a Fair Fight?

Dan Harmon*, Charlie Clements

Cheatgrass Dead Zones in Northern Nevada

Tye Morgan*, Robert Blank, Charles Clements

Cheatgrass Invasion Increases Wildfire Frequency and Size by Altering Fuel Characteristics

*Kirk Davies**

Classification and Expansion Detection of Western Juniper Using Historical Aerial Imagery

Nathan Cline, Timothy Deboobt, Micheal Fisher, Steven Petersen*

Classification of Lentic Riparian Areas: Challenges and Opportunities

*Linda Vance**

Climatic Control of Sagebrush Survival in Semi-Arid Ecosystems of Nevada

Erin Hourihan, Barry Perryman*

Clover Seeding for Sage-Grouse Habitat and Forage Production on Mountain Meadows

Matt Barnes, Joe Brummer, Lars Santana, John Scott, Mark Volt*

Collaborative Partnerships for Grassland and Prairie Habitat Restoration Projects with Aminopyralid

Byron Sleugh, Mary Halstvedt, Vanelle Peterson, D. Chad Cummings, Dean Gaiser, Jerry Benson, Mike Finch, Robert Wilson, Scott Nissen, Roger Becker, Mike Moechnig, Mark Renz*

Collection of Very-High-Resolution Images from a Remotely Piloted Rotary Wing Vehicle: Applications in Utah Rangeland Monitoring

D. Bracken Davis, Scott Heath, Jan Knerr, Mark C. Quilter*

Communicating Effectively with Livestock Producers

*Fee Busby, Rick Caquelin, Steve Hedstrom, Justin Meissner, John Hollenback**

Communicating Effectively with Livestock Producers

*Fee Busby**

Community Responses to Climate Variability Over 50 Years in a Subalpine Rangeland

Lafe Conner, Richard Gill*

Comparing Grazed Allotments in Arizona on Their Ability to Convert Precipitation to Vegetation

Philip Heilman, Stephen Hagen*

Comparing Methods of Rangeland Measurements: Proper Design and Statistical Analysis

*Corey Moffet**

Comparing Seed Mixes and Seeding Techniques for Restoring Plant Communities in Wyoming's High Desert

Karen J. Clause, Susan R. Winslow, James S. Jacobs*

Comparing the Impacts of Water Quality Regulations on Land Use in Two Watersheds: Lake Taupo (NZ) and Tomales Bay, California (USA)

Sheila Barry, Stephanie Larson, Warren King, Michael Lennox*

Comparing the SamplePoint and Point Intercept Monitoring Methods

Jim Cagney, Terry Booth, Samuel Cox*

Comparing Two Ground-Cover Measurement Methodologies for Semiarid Rangelands

Keith Weber, Fang Chen, D. T. Booth, Mansoor Raza, Kindra Serr, Bhushan Gokhale*

Comparison of the Effects of Fire on Sagebrush Steppe 3-Dimensional Structure and Biomass using Fusion of Terrestrial Scanning Laser and Airborne Digital Photography

Robert A. Washington-Allen, Vincent Mendieta, D. Terrance Booth, W. Eric Limbach, Sorin Popescu*

Competition of Native Grasses from Invasion Transplanted into Russian Knapweed and Canada Thistle

Brian Sebade, Ann Hild, Brian Meador, Thomas Smith*

Conifer and Abiotic Factors Influence on Big Sagebrush Cover

Karen Kitchen, Brittany Mendelsohn, Michael Frisina, Bok Sowell*

Conquering Social and Ecological Fire Thresholds to Empower and Equip Ranchers to Manage Rangelands

Charles Taylor, Dirac Twidwell, William Rogers*

Conservation of *Draba* in the Intermountain West: The importance of hybridization, ploidy, breeding system, endemism and biogeography.

Loreen Allphin, Michael Windham*

Contribution of Warm and Cool Season Grasses to Seasonal Herbage Availability in Loamy and Sandy

Mixed Prairie Range Sites of Alberta

Edward Bork, Barry Irving, Tanner Broadbent*

Controlling Japanese Brome with Grazing Management in Judith Basin County, Montana

*Rick Caquelin**

Cottonwood Seedling Demography along the Upper Missouri River

*Gregor Auble, Michael Scott, Michael Merigliano, Chad Krause**

Crested Wheatgrass Control and Native Plant Establishment in Utah

April Hulet, Bruce Roundy, Brad Jessop, Jennifer Rawlins*

Crested Wheatgrass Diversification: Practical Experiences

*Jerry Benson**

Crested Wheatgrass Impedes the Spread of an Exotic Annual Grass

Aleta Nafus, Kirk W. Davies, Roger Sheley*

Crossings, Corridors and Trophic Cascades: Wolves and Woody Vegetation in Banff National Park

*Clifford A. White**

Crossings, Corridors and Trophic Cascades: Wolves and Woody Vegetation in Banff National Park

*Cliff White**

CRP...A Duck's Best Friend

*Bob Sanders**

Database for Inventory, Monitoring and Assessment (DIMA)

Richa Courtright, Barry Lavine, Jason Karl, Scott Schrader, Brandon Bestelmeyer, Laura Burkett, Jeff Herrick*

Deleterious Composition and Quality of Pronghorn Diets in Southern Arizona

*Clare Mix, William Miller**

Demonstration of Restoration Approaches on a Wetland Reserve Project

*Kathy Pendergrass, Dean Moberg, Joe Williams**

Density of Crested Wheatgrass and Native Perennial Bunchgrasses 12-Years after Co-Planting

Aleta Nafus, Kirk W. Davies*

Developing and Implementing a Strategy for the Conservation of Shrub Steppe/Rangelands in South Central Washington

*Julie Conley**

Developing Native Plant Materials and Applying Management Practices to Repair Disturbed Landscapes

*Jack Staub**

Development of a Fungal Seed Bank Pathogen for Cheatgrass Biocontrol on Intermountain Rangelands

Susan E Meyer, Julie Beckstead, Phil S Allen*

Development of a Habitat Appraisal Guide for Rio Grande Wild Turkeys in South Texas

Chase Currie, Alfonso Ortega, William Kuvlesky Jr., Leonard Brennan, Stephen DeMaso*

Development of a State-and-Transition Model for the Middle Sheyenne River

Miranda Meehan, Jeff Repp, Edward DeKeyser, Kevin Sedivec, Joseph Zeleznik, Jack Norland*

Development of Most Similar Neighbor (MSN) Polygons for use with the Burning Risk Advisory Support System (BRASS) on Fort Hood, Texas

Edward Rhodes, William Shaw, R. Loren Naylor, Timothy Brown, Wayne Hamilton, J. Richard Conner, Jason Jones, Jay Angerer*

Differential Responses of *Poa pratensis* and *Festuca campestris* to Defoliation and Microenvironment

Steven Tannas, Edward Bork, Walter Willms*

Digital Charting Technologies and their Applications on Rangelands

Patrick Clark, Douglas Johnson, Michael Johnson, Mounir Louhaichi*

Distribution of a Rare Sand Dune Legume Limited by Deer Herbivory at Multiple Scales

Darcy Henderson, Sarah Lowe, Christiane Catellier, Eric Lamb, Xulin Guo*

Diversifying Crested Wheatgrass Seedlings in Northern Nevada

Kent McAdoo, John Swanson, Nancy Shaw*

Do Cultivation Land-Use Legacies Affect Rangeland Seeding Success?

Lesley Morris, Thomas Monaco, Roger Sheley, Justin Williams*

Downwind Rangeland Smoke: Flint Hills Case Study

Brian Obermeyer, Kristen Hase*

Dryness and Desperate Measures: A Political Ecology of Ranching in the Rocky Mountain West

Kristin Gangwer, William R. Travis*

Ecological Sites: Organizational Tool for Outcome-Based Land Management

Justin Derner, Joel Brown, Jack Alexander*

Ecologically-Based Land Management on *Bromus tectorum* Invaded Great Basin Shrublands: An Ecosystem Assessment

Beth Fowers, Merilynn Hirsch, Thomas Monaco, Chris Call*

Ecology of Biotic Soil Crust Lichens of Oregon's Sagebrush Steppe

*Heather Root**

Economic Flow-Model for Western Rangelands: Using Economic Principles to Guide the Allocation of Conservation Resources

Michael Taylor, Kimberly Rollins, Laine Christman*

Ecophysiological Role of Leadplant (*Amorpha canescens*) in the Semi-Arid Grasslands of the Nebraska Sandhills

Jessica Milby, Adam Yarina, Walter Schacht, Tala Awada*

Ecosystem Services: The New Motive for Range Improvements

Allen Torell, Neil Rimbey, John Tanaka*

Effect of a Wildfire on Old Aerated and Prescribed Burned Sites: Vegetation Diversity and Exotic Grasses

Felix Ayala-A., J. Alfonso Ortega-S., Timothy E. Fulbright, G. Allen Rasmussen, D. Lynn Drawe, David R. Synatzske, Andrea R. Litt*

Effect of Landform Position on Mesquite Growth Patterns

Fredrich Schrank, Roger Wittie, Carol Thompson, R. J. Ansley*

Effect of Management Practices on Spatial Utilization by Cattle (*Bos spp.*) on Rangeland in South Florida

Brandee Williams, MJ Williams*

Effects of a Single Grazing Event by Cattle on Terrestrial Invertebrates Falling Into Streams and Trout Populations: Results of a Field Experiment

W. Carl Saunders, Kurt D. Fausch*

Effects of Bitterweed Ingestion on Reproduction in Rambouillet Rams

Derrick Fuchs, Cody Scott, Micheal Salisbury, Corey Owens*

Effects of Changing Spatial and Thematic Scale for Mapping Greater Sage-Grouse Habitat

Virginia Harris, Eva Strand, Jocelyn Aycrigg*

Effects of Climate/Vegetation and Level of Herbivory on Soil Carbon and Nitrogen in Semi-Arid Rangelands

Doug Tolleson, John Kava*

Effects of Fire and Herbivory on Sentinel Species across the Landscape of Northeastern Montana

Angela Reid, Samuel Fuhlendorf*

Effects of Fuel Load, Heterogeneity, and Environmental Conditions on Fire Behavior in Grasslands - Results from a Physics Based Process Model

Eva Strand, Chad Hoffman, Stephen Bunting*

Effects of High-Density, Short-Duration Planned Livestock Grazing on Soil Carbon Sequestration Potentials in a Coastal California Mixed Grassland

Kristina Wolf, Brent Hallock, Robert Rutherford, Marc Horney, Anthony O'Geen, Royce Larsen*

Effects of Liquid Smoke on Seed Germination of Shortgrass Prairie Plant Species

Yifang Chou, Robert Cox*

Effects of Off-Road Vehicles on Rodents in Sonoran Desert Rangelands

Simon Reid, Ward Brady*

Effects of Patch Burning and Livestock Grazing on Grasshopper Populations in Northern Mixed Prairie in Eastern Montana

David Branson, Lance Vermeire*

Effects of Prescribed Burning and Litter Type on Litter Decomposition and Nutrient Release in Mixed-Grass Prairie in Eastern Montana

Kurt Reinhart, Aaron Roth, Lance Vermeire*

Effects of Weed Induced Alteration of Plant Composition on Patterns of Vegetation Recovery Following Herbicide Control of Leafy Spurge

Stefanie Wacker, Jack Butler*

Efficient and Effective Methods for Monitoring Ecological Integrity on Grazed Lands

Laura Applegate, Linda Hardesty*

Environmental Influences on Structural Characteristics of Cheatgrass (*Bromus tectorum*)

Charles Sloane, Clayton B. Marlow*

ESD Development Technical Workshop

Jamin Johanson, Shane Green, Sarah Quistberg, Jacob Owens*

Establishment and Persistence of Native Grass in Wyoming's High Desert

Susan R. Winslow, Karen J. Clause, James S. Jacobs*

Establishment of Invasive Species in Post-Fire Seeding Treatments

Megan M. Taylor, Ann L. Hild, Nancy L. Shaw, Erin K. Denney*

Estimating Desert Rangelands Forage Production with High Spatial Resolution Satellite Imagery and Vegetation Indices

Ahmed Mohamed, Jerry Holechek, Derek Bailey*

Estimating Influence of Stocking Regimes on Livestock Grazing Distributions

Matthew Rinella, Marty Vavra*

Estimating Prickly Pear (*Opuntia*) Pad Density by Line Intercept, Belt Transect, and Quadrat Methods

*David Barre, Kurt Huffman, Dale Rollins, Dean Ransom, Jr**

Estimating Seed Production and Plant Age of Mountain Big Sagebrush (*Artemisia tridentata* ssp. *vaseyana*)

Melissa L. Landeen, Steven L. Petersen, Stanley G. Kitchen, Peter J. Weisberg, Brian A. Reeves, Kevin A. Costa*

Estimating the Cost of Replacing Forage Losses on California Annual Rangeland

Theresa Becchetti, Neil McDougald, William Frost, James Sullins*

Evaluation and Use of Sunn Hemp (*Crotalaria juncea* L.) at the Manhattan Plant Materials Center (PMC), Manhattan, Kansas

P. Allen Casey, Richard L. Wynia, John M. Row*

Evaluation of Freeze-Thaw Dynamics in Hummocked Wetlands

Mae Smith, Paul Meiman, Joe Brummer*

Evaluation of Habitat Use by Sharp-Tailed Grouse on the Grand River National Grasslands in Northwest South Dakota

Dean Houchen, Benjamin Geaumont, Christopher Schauer, Kevin Sedivec*

Evaluation of Sand Sagebrush Control in a Southern Mixed Prairie: Implications for Lesser Prairie Chicken Habitat Management

Eric Thacker, Robert Gillen, Stacey Gunter, Tim Springer*

Evaluation of the Tenderness, Size, and Marbling of Forage-Finished Ribeye Steaks Produced in Kauai County, Hawaii

Matthew Stevenson, Yong Soo Kim, Glen Fukumoto*

Examining Disturbance and Environmental Mechanisms Regulating Plant Species Dynamics in Native *Festuca campestris* Grassland

Steven Tannas, Edward Bork, Walter Willms*

Expediting State-and-Transition Models through Sorting of Ecological Sites into Disturbance Response

Groups

Tamzen Stringham, Patti Novak-Echenique, Erica Freese, Lucas Wiseley, Patrick Shaver*

Experimental Comparison of Pre-Emergence Herbicides for Reducing Annual Grass Emergence in Two Great Basin, USA Soils

Marilynn Hirsch, Thomas Monaco, Corey Ransom, Christopher Call*

Expiring CRP: Alternative Management Systems to Sustain Wildlife Habitat Values

*Ben Geaumont**

Extension Outreach in Tropical Range and Livestock Management for Pacific Islanders

Mark Thorne, Jonathan Deenik, Robert Godfrey, Glen Fukumoto, John Powley, Matthew Stevenson, Lawrence Duponcheel, Alejandro Badilles*

Factors Limiting Use of Drought Mitigation Tactics among Utah Cattle Ranchers

*D. Layne Coppock**

Farmers' Perception about Voisin Management Intensive Grazing and Ecosystem Services

Juan P. Alvez, Abdon Schmitt, Joshua Farley*

Feature Mapping on Extensive Landscapes Using GPS-Enabled Computers

Stephen K. Ndzeidze, Craig A. Carr, Adele L. Woerz, Mounir Louhaichi, Patrick E. Clark, Douglas E. Johnson*

Federal Agencies and Ranchers Working Together - Keys to a Successful Partnership

TJ Mabey, Gracian Uhalde*

Field Establishment of Perennial Grass Seedlings in Cheatgrass Invaded Systems

Elizabeth Leger, Erin Goergen, Courtney Rowe*

Field Test of Digital Photography Biomass Estimation Technique in Tallgrass Prairie

Sherry Leis, Lloyd Morrison*

Fine-Scale Observations of Soil Properties in Hummocks and Adjacent Interspaces

Paul Meiman, Mae Smith, Joe Brummer, Terrance Booth, Larry Griffith*

Fire and Post-fire Soil Erosion

Lance Vermeire, Corey Moffet*

Fire Effects on Global CO₂ Emissions and Soil Carbon

*Jim Ansley**

Fire in the Sagebrush Biome: An Inherent Process versus Management Tool

*Richard Miller**

Fire Rehabilitation Decision Making

Bruce Roundy, April Hulet, Nathan Cline, Lean Crook, Kert Young, Matthew Madsen*

Fire, Herbicide and Disking Effects on Diversifying Crested Wheatgrass Stands in the Northern Great Plains

*Lance Vermeire**

Food Habits and Diet Quality of Mule Deer Wintering on the North Kaibab Plateau of Arizona

Matthew Acton, William Miller, Ann Steffler*

Forage Kochia (*Kochia prostrata*): Rangeland Rehabilitator or Exotic Invader?

Erin C. Gray, Patricia S. Muir*

Forage Nutrient Availability and Reproductive Success of Semi-Wild Bison in Western Montana, USA

Kelsey Guffey, Neto Garcia, Clayton Marlow*

Forage Production and Quality, Cattle Performance, Economic Return, and Soil Health from Annual Forages Used for Late-Season Grazing in North Dakota

Andrew Fraase, Bryan Neville, Kevin Sedivec, Dennis Whitted, Paul Nyren, Greg Lardy*

Forage Quality Dynamics of Warm Season Grasses During the Growing Season in West-Central Texas

Joel Douglas, Homer Sanchez, George Peacock, Kenneth Spaeth, Gary Rea, James Muir*

Foraging for Rangeland Information in an Unfamiliar Virtual World

Rachel Frost, Merrita Fraker-Marble*

Forecasting Annual Aboveground Net Primary Production in the Intermountain West

Julie Finzel, Mark Weltz, Mark Seyfried, Jim Kiniry, Karen Launchbaugh*

Forest Service and Defenders of Wildlife Team Up to Implement Non-Lethal Control of Prairie Dogs

Randall L. Griebel, Shelly L. Gerhart, Terri Harris*

Fostering Healthy Lands for Small Acreage Success in South Dakota

Dusty Jager, Penny Nester, Mindy Huberty, Roger Gates, Rebecca Bott*

Functional Traits and Their Use in Plant Improvement

Jeremy James, Tom Jones*

Genetic and Environmental Influences on Distribution Patterns of Beef Cattle Grazing Foothill Rangeland

Derek Bailey, Delyn Jensen, Milt Thomas, Darrin Boss, Robin Weinmeister, Robert Welling*

Geographic Variation in Crown Structure and Foliage Biomass of Woodland Trees across the Great Basin

Robin Tausch, Neil Frakes, Richard Miller, Bruce Roundy*

Germination Prediction from Soil Moisture and Temperature Data across the Great Basin

Nathan Cline, Bruce Roundy, Stuart Hardegree*

GIS Tools, Courses, and Learning Pathways Offered by The National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT)

Eva Strand, Kathy Schon, Jeff Jones*

Government Success in Partnerships: The USDA-ARS Area-Wide Ecologically-Based Invasive Annual Grass Management Program

Brenda Smith, Roger Sheley*

Grass Seedling Demography in the Great Basin: Implications for Restoration

Jeremy James, Tony Svejcar, Matt Rinella*

Grasshoppers! Grasshoppers! Grasshoppers!

*Linden Greenhalgh**

Graze Period Stocking Rate, Stock Density Affect Dietary Intake Independently

Tim J. Steffens, Matt K. Barnes, Larry R. Rittenhouse*

Grazing Distribution Patterns of Beef Bulls and Cows During the Breeding Season in Central New Mexico

Adrienne Lipka, Derek Bailey, Steven Lunt, Milt Thomas, Morgan Russell, Shad Cox, Richard Dunlap*

Grazing Management Effects on the Soil Health in Mixed-Grass Prairie within the Missouri Coteau Region of North Dakota

Guojie Wang, Kevin Sedivec, Paul Nyren, Anne Nyren*

Grazingland and Economic Sustainability: The Balancing Act

*Jeff Goodwin**

Great Basin Native Plant Selection and Increase Project: A Science/Management Success

Mike Pellant, Nancy Shaw*

Growth Dynamics of *Hesperostipa comata* and *Pascopyrum smithii* in Alberta Dry Mixedgrass Prairie

Tanner Broadbent, Edward Bork, Walter Willms*

Habitat Selection by Free Ranging Feral Horses in the Alberta Foothills

Tisa Girard, Edward Bork, Mike Alexander, Craig Demaere*

Harvest Efficiency of High Stocking Density Grazing

Alexander Smart, Jerry Volesky, Sara Winterholler, Walter Schacht, Eric Mousel, Jordan Johnson, Robert Valvala, John Madison*

Healthy Rangeland Watersheds and Productive Livestock Enterprises: Why Not?

Kenneth Tate, Leslie Roche, Theresa Becchetti, David Lile, David Lewis, Anthony O'Geen, Randy Dahlgren, Melvin George, Edward Atwill*

Herbivore Impacts on Life-Stage Transitions of an Endangered Orchid, *Spiranthes parksii* Correll

Carissa L. Wonkka, William E. Rogers, Fred E. Smeins, Dirac Twidwell*

Highlights of the 2010 RPA Rangeland Assessment

Matt Reeves, John E. Mitchell (Emeritus)*

Historical Global Fire Context: Linking Landscapes and Ecosystems

*Ryan Limb**

History of Crested Wheatgrass (*Agropyron*) in North America

*Kevin Jensen**

Home Range, Habitat Selection, and Survival of Greater Roadrunners

*Dean Ransom, Jr.**

Hope On The Range: A Great Basin Educational Project

Gary McCuin, Steve Foster, Kent McAdoo, Ron Torell, Rick Orr, Margaret Orr*

How Developing and Following Through with a Resource Management Plan Has Improved the Range and Relationships with Ranchers in the Cody Wyoming Bureau of Land Management Office

Dallen Smith, Jack Mononi, Mike Smith*

How Water Development can Increase the Carrying Capacity of the Land and Improve Riparian Areas

Dallen Smith, Dee Hillberry, Mike Smith*

Hydrologic Vulnerability of Great Basin Sagebrush-Steppe Following Pinyon and Juniper Encroachment

C. Jason Williams, Frederick B. Pierson, Patrick R. Kormos, Stuart P. Hardegree, Patrick E. Clark, Osama Z. Al-Hamdan*

Hydrothermal Indices for Classification of Seedbed Microclimate

Stuart Hardegree, Jaepil Cho, Bruce Roundy, Corey Moffet, Thomas Jones, Jeremy James, Nancy Shaw, Robert Cox*

I. Trophic Cascades Involving Large Predators, Wild Ungulates, and Plants in the Western US: Do Large Predators Have a Role?

Robert Beschta, William Ripple*

Identification of Plant Functional Groups as Indicators of Ecological Condition in Wet Meadows (Lentic Sites) of the Sierra Nevada, California

*Dave Weixelman**

II. Impacts to Riparian Biodiversity and Channel Morphology Following Large Predator Loss in Several Ecosystems of the Western US

Robert Beschta, William Ripple*

Impact of Sheep Grazing on Demographic Parameters of Cheatgrass (*Bromus tectorum*) and Wild Oat (*Avena fatua*) in Three Common Montana Agricultural Systems

Melissa Graves, Jane Mangold, Hayes Goosey, Patrick Hatfield, Fabian Menalled*

Impact of Wetland Restoration on Forage Productivity of Prairie Pothole Wetlands

*Etienne Soulodre**

Impacts of Native and Exotic Grasses on Forb Seedling Growth and Establishment

Hilary Parkinson, Cathy Zabinksi, Nancy Shaw*

Implications for Future Research

*James Dobrowolski**

Improvement in Ecological Status with Grazing Management and Range Chiseling

Matthew J. Ricketts, Jim Jacobs, Keith Schott, Sonny Smith*

Improvement of Seed Production in Utah Sweetvetch

Michael Peel, Ivan Mott*

Improving the Credibility of State-and-Transition Models

Jamin Johanson, Christopher Call, Shane Green*

Increasing Diversity in Crested Wheatgrass Stands in Eastern Idaho

*Corey Moffet**

Increasing Native Plant Diversity in Crested Wheatgrass Stands: Theory, Practice and Problems

*Val Anderson**

Information Technology for Regional Collaboration in the Great Basin

Sean Finn, Thomas Zarriello, Linda Schueck, Ruth Jacobs*

Integration of Herbicides into Wildlife Habitat Restoration Programs in Southwestern Rangelands

D Chad Cummings, Robert Masters, Greg Alpers, Vernon Langston*

Inter and Intra-State Cooperation: Nevada Partners for Conservation and Development

*Lee Turner**

Interaction between Morphological Development and Burning Effectiveness in Kentucky Bluegrass and Smooth Bromegrass

*John Hendrickson**

Interagency Creeks and Communities Strategy

*Laura Van Riper**

Internet Technologies for Rangeland Ambassadors

Lovina Roselle, Cody Sheehy, Karen Launchbaugh*

Investigating the Soil Microbial Community Structure Under Reclaimed Roads in North Dakota

Eric Viall, Laura Overstreet, David Hopkins*

Is Livestock Production for the Birds?: Linking Grazing Management and Grassland Birds in North American Shortgrass Steppe and Mixed-Grass Prairie

Allison Henderson, David Augustine, Justin Derner, Stephen Davis*

Is Rehabilitation of Non-Forestlands after Wildfires Effective? - A Systematic Literature Review

David A. Pyke, Jan L. Beyers, Troy A. Wirth*

LANDFIRE Tools and Data Useful for Range Management: Explore the Past, Plan for the Future

Randy Swaty, Jim Smith, Sarah Hagan, Jeannie Patton, Kori Blankenship*

Landowner, NGO and Local Government Cooperation: The Owyhee Initiative

*Chad Gibson**

Landscape Associations, Water Chemistry, Human Use, and Characteristics of Great Basin Spring-Fed Aquatic and Riparian Communities

*Donald Sada**

Land-Use Legacies Affect Species Performance Nearly a Century after Cultivation

Lesley Morris, Thomas Monaco, Robert Blank, Elizabeth Leger, Roger Sheley, Tye Morgan*

Locating Monitoring Sites in a Mixed Ownership Landscape

*Edward Petersen**

Long Term Effects of Aeration and Fire on Invasion of Exotic Grasses in Mixed Brush Plant Communities as Affected by a Wildfire

Felix Ayala-A., J. Alfonso Ortega-S., Timothy E. Fulbright, G. Allen Rasmussen, D. Lynn Drawe, David R. Synatzske, Andrea R. Litt*

Look Closer: Time Sequence Photography of Roosters Comb in the Sheep Creek Range

Tye Morgan, Robert Blank*

Low-Cost Camera Modifications and Methodologies for Very-High-Resolution Digital Images

E. Raymond Hunt, James Carr, W. Dean Hively*

Making Good Things Happen - Working on the Ground with the Landowner

Steve Hedstrom, Rick Caquelin*

Managing CRP Grasslands: Short- and Long-Term Effects of Haying on Breeding Bird Populations in CRP Grasslands in the Northern Great Plains

Lawrence Igl, Douglas Johnson*

Managing Fire and Fuels in the Northeast Mojave Desert: The Mojave Desert Initiative

*Scott Florence**

Managing Rangelands for Greenhouse Gas Mitigation: Opportunities and Tradeoffs

Mark Liebig, Alan Iwaasa*

Managing Rangelands for Multiple Ecosystem Services: Beyond Bement (1969)

*Justin Derner**

Managing Rangelands for Multiple Ecosystem Services: Opportunities and Tradeoffs

*Justin Derner**

Mapping Cheatgrass in the Great Basin Using 250-Meter eMODIS NDVI

Stephen P. Boyte, Bruce K. Wylie, Collin G. Homer, Donald J. Major*

Mapping Leafy Spurge Density in Madison Country, Montana, with Hyper-Spectral-Spatial-Temporal Imagery

Rick Lawrence, Steven Jay, Kevin Repasky, Lisa Rew*

Mechanically Shredding Utah Juniper

Kert Young, Bruce Roundy*

Mechanisms Responsible for Enhancing the Restoration of *Festuca campestris* into a *Phleum pratense* Dominated Plant Community on a Pipeline RoW

Steven Tannas, Doug Clark*

Mesquite Seedling Disappearance Under Goat Browsing

Landon Pyle, Cody Scott, Corey Owens*

Modifying the USDA-NRCS Pasture Condition Score System to Include Weighted Indicators

*Matt Sanderson**

Monitoring Groundwater-Dependent Ecosystems on National Forest Service Lands

Kathleen Dwire, Joseph Gurrieri, Christopher Carlson, Marc Coles-Ritchie, Stephen Solem, Allison Aldous, Devendra Amatya, Trish Carroll, Barry Johnston, Linda Spencer*

Monitoring of Livestock Grazing Effects on Bureau of Land Management Land

Kari Veblen, David Pyke, Cameron Aldridge, Mike Casazza, Timothy Assal, Melissa Farinha*

Monitoring Plant Species Richness When it Won't Sit Still: Handling Temporal Variability in Vegetation Monitoring

Amy Symstad, Robert Gitzen, Jayne Jonas*

Monitoring Rangelands with Very-Large Scale Aerial Surveys: Advantages and Limitations

D. Terrance Booth, Samuel E. Cox*

Monitoring Shrub Canopy Cover Using Vegetation Charting Technique

*Mounir Louhaichi, Hani Al-Homsh, Fahim Ghassali, Osama Shalouf, Douglas E. Johnson**

Monitoring the Efficacy of Biocontrol on Diffuse Knapweed (*Centaurea diffusa*) in British Columbia's Southern Interior

Don Gayton, Val Miller*

Moving Beyond the Myths and Traditions of Fire Behavior in Rangelands

Dirac Twidwell, William Rogers, Samuel Fuhlendorf, Charles Taylor, Jr., David Engle*

Multiple Uses and Associated Values on Canadian Publicly Managed Rangeland: A Case Study of the Federal Community Pasture Program

*Brant Kirychuk**

Multiple-Paddock Planned Grazing Distributes Utilization across a Heterogeneous Landscape

Matt Barnes, Jim Howell*

Multi-Scale Mechanisms and Effects of Fire Grazing Interactions

Brady Allred, Samuel Fuhlendorf*

National Estimates of Soil Loss on Rangelands

Mark Weltz, Leonard Jolley, Ken Speath*

Native and Shrub Tolerance to Aminopyralid (Milestone® Herbicide) Applications for Invasive Species Control

Mary Halstvedt, K. George Beck, Roger Becker, Celestine Duncan, Rodney Lym, Peter Rice*

Native Grasses Evaluation for Reseedings in Northeast Mexico

Eduardo A. Gonzalez-V., J. Miguel Avila-C., J. Alfonso Ortega-S.*

Nature's Engineers - Wildlife as Agents of Ecological Change

Wendell Gilgert, Kent McAdoo, Marty Vavra*

New Paradigms for Collaborative Research and Management in the Great Basin

*Stuart Hardegee**

New Rangeland and Pasture Herbicide Product Formulations from Dow AgroSciences LLC.

Vernon Langston, Pat Burch, Chad Cummings, Bill Kline, Byron Sleugh, Mary Halstvedt, Vanelle Peterson*

Non-Fee Grazing Costs: Historical Review and Implications to Public Land Grazing Fees

Neil R. Rimbey, L. Allen Torell*

No-Till Interseeding Yellow-Flowered Alfalfa (*Medicago sativa* subsp. *falcata*) into Crested Wheatgrass (*Agropyron cristatum*) Stands: Initial Establishment

Christopher Misar, Lan Xu, Roger Gates, Arvid Boe, Patricia Johnson, Christopher Schauer*

Novel Herbivores and Disturbance, Biotic Resistance, Community Structure, and Environmental Factors: Multi-Process Control over the Invasibility of North America's Endangered Wyoming Big Sagebrush Ecosystems

Michael Reisner, James Grace, David Pyke, Paul Doescher*

NRCS - USFWS Conference Report

*Terrell Erickson**

NRCS Conservation Planning and Use of Monitoring and Business Planning Information

Gene Fults, Chuck Stanley*

NRCS Sage-Grouse Initiative: Montana Example

*Joe Fidel**

NRCS Sage-Grouse Initiative: Overview and Structure

*Tim Griffiths**

Nutritional Composition of *Carex sprengei* in North Dakota

Miranda Meehan, Edward DeKeyser, Kevin Sedivec, Jack Norland*

Nutritive Value of Pasture Weeds in Oregon

Amy Peters, Shelby Filley, Andrew Hulting*

Object-Oriented Segmentation and Classification of High Resolution Imagery Evaluating Fire-Carrying Fuel Variables of Pinyon-Juniper Woodlands in the Great Basin

April Hulet, Bruce Roundy, Steve Petersen, Stephen Bunting, Ryan Jensen*

Optimized Plant Frequency as a Surrogate Measure for Species Abundance - Potential Applications to VHR Image

Michael DeBacker, John Heywood*

Optimizing Regional Collaborative Efforts to Achieve Long-Term Discipline-Specific Objectives

Frederick B. Pierson, Peter R. Robichaud, Kenneth E. Spaeth, C. Jason Williams, Osama Z. Al-Hamdan*

Orthorectification, Mosaicking, and Analysis of Sub-Decimeter Resolution UAV Imagery for Rangeland Monitoring

Andrea Laliberte, Craig Winters, Albert Rango*

Overview of the Role of Fish and Wildlife in Determining Plant Succession and Directing Plant Community Phases

Wendell Gilgert, Jeremy Maestas*

Owl Mountain Partnership

*Peter Torma**

Pasture and Grazing Management in the Northwest: A New Guidebook

Glenn Shewmaker, Mylen Bohle*

Pastures of Deserted Animal Industries of Uzbekistan

T. Mukimov, R. Haiitbaev, Sh. Sindarov*

Patch Size Controls Selectivity of Sheep Grazing Grass-Clover Grasslands

Emilio Laca, Cristina Genro, Carolina Bremm, Jairo Genro, Craig Schriefer*

Patterns of Woodland Overstory/Understory Successional Changes over a Central Nevada Elevational Gradient

Robin Tausch, Alicia Reiner*

Payments for the Provision of Ecological Goods and Services

*Peter Boxall**

Peatlands: Ecology and Conservation

Steve Shelly*

Perceptions of Targeted Grazing in the Desert Southwest

Corrine Knapp, Maria Fernandez-Gimenez, Retta Bruegger, Larry Howery, Allen Torell, Derek Bailey*

Pick the Low-Hanging Fruit First: Oregon's Strategy to Benefit Sage-Grouse by Removing Juniper

*Jeremy Maestas**

***Pinus ponderosa*: An Examination into its Past, Present, and Future Suitable Habitat in Arizona**

Matthew P. Peters, Ward W. Brady*

Plains Prickly Pear: Demography and Response to Grazing on the Shortgrass Steppe

Lynn M. Moore, William K. Lauenroth*

Plant and Animal Responses to Targeted Grazing of White Locoweed in New Mexico

Laura Jacobson, Andres Cibils, David Graham, Lyndi Owensby, Wendy Taylor, Kirk McDaniel*

Plant Materials Development for Disturbed Southwestern Landscapes

Gregory Fenchel, Joe Aragon, David Dreesen, Danny Goodson, Keith White*

Plant Materials Development in the Southern Rocky Mountains

*Steve Parr**

Plant Materials Establishment and Performance on Gas Well Pads

James Jacobs, Karen Clause, Susan Winslow*

Plant Selection Strategies for Improved Plant Establishment in Saline Environments

*John Lloyd-Reilley**

Planting Date Influences Germination and Seedling Demography of Bluebunch Wheatgrass

Chad Boyd, Jeremy James*

PLANTS and VegSpec - Plant Characteristics, Taxonomy, and Restoration Tools

*David Pyke**

Post-Fire Soil Water Repellency, a Preliminary Report: Extent and Characteristics within the Pinyon-Juniper Woodlands of the Eastern Great Basin

Daniel Zvirzdin, Matthew Madsen, Bruce Roundy*

Potential Native Species for Mitigating Fire and Weed Invasion

*Christine Taliga**

Potential Use of Molecular Markers for Development of Native Plants

*Steven Larson**

Practical Sample Design and Selection Tools for Rangeland Monitoring and Assessment

*Jason Karl**

Prairie Pothole Wetlands: Characteristics, Functions, and Values

*Brian Tangen**

Predicting Direct Fire-Induced Mortality of Four Prominent Rangeland Graminoids

Kimberly Haile, Lance Vermeire, Clayton Marlow*

Predicting Nutritive Value of Desert Bighorn Sheep Forage Using Near Infrared Spectroscopy

John A. Kava, Douglas R. Tolleson*

Predicting Potential Soil Aggregate Stability and Understanding Departure from Potential: A Climate-Soil-Vegetation Envelope Model Approach

Michael Duniway, Kenneth Spaeth, Jeffrey Herrick*

Predicting the Spread of Invasive Plant Species Under a Rangeland Climate Change Scenario

Robbie Lee, Gary Bradfield, Maja Krzic, Reg Newman, Brian Wallace*

Predicting Wolf (*Canis lupus*)-Cattle (*Bos taurus*) Encounters and Consequential Effects on Cattle Resource Selection Patterns

Patrick Clark, D. Joseph Chigbrow, Kelly Crane, John Williams, Larry Larson, Douglas Johnson*

Preliminary Results for Rapid Determination of Sagebrush Using DNA Recovered from Cattle Feces

Jose Alberto Perez-Amaro, Ricardo Mata-Gonzalez, Tim DeCurto, David Bohnert, Oscar Riera-Lizarazu, Chad Boyd, Jeff Leonard*

Prescribed Burn Associations: Getting Landowners to Use Prescribed Fire

*John Weir**

Preserving CRP Grassland Benefits in Western Nebraska

Kristin L. Miller, Jerrold R Spiker, Galen Wittrock, Emily Munter*

Proper Grazing Management During Drought: The Difference between Making a Profit and Losing Your Herd

Carlos Gonzalez, Alfonso Ortega-S., Steven Lukefahr*

Pyric Herbivory in Action on Boreal Rangelands? The Fire-Grazing Interaction of Wood Bison in Northeast British Columbia, Canada

Sonja Leverkus, Sam Fuhlendorf*

Pyric Herbivory in Central Montana Sagebrush Communities: Contrasting Domestic and Native Herbivores

Ilana Bloom-Cornelius, Samuel D. Fuhlendorf*

Quantifying Wildlife Habitat for State and Transition Models Developed in the Sagebrush-Steppe of Northwest Colorado

Willow Hibbs, Roy Roath, Maria Fernandez-Gimenez*

Rainfall Interception and Partitioning by *Pinus monophylla* and *Juniperus osteosperma*

Samuel Lossing, Tamzen Stringham, Mark Weltz*

Ranch-Level Economic Impacts of Predation in a Range Livestock System

Benjamin S. Rashford, Thomas Foulke, David T. Taylor*

Range Camp on the Western Fringe - California-Pacific Section

Julie Finzel, Marc Horney, Cece Dahlstrom*

Range Cattle Winter Water Consumption in Eastern Montana

M. K. Petersen, Jennifer Muscha, Travis Mulliniks*

Rangeland and Pasture Weed Control with Aminopyralid + 2,4-D

Vernon Langston, Chad Cummings, Byron Sleugh, Pat Burch, Bill Kline*

Rangeland Technology and Equipment Workshop: Diversification of Crested Wheatgrass Stands

Robert Cox, Mike Pellant, Nancy Shaw*

Rangeland Web Resources: Making Your Proposals More Competitive

*James Dobrowolski**

Rangelands in Large-Scale: History and Future

*Paul Tueller**

Rangelands of the Wakhan Corridor: Description, Issues, and Concerns

*Don Bedunah**

Rangelands on eXtension: Compiling the Best of the Best for Rangelands

Rachel Frost, John Tanaka, Lovina Roselle, Mindy Pratt*

Rangelands Use Efficiency and Wool Production in the Arid Environment of Uzbekistan

*E. Mamedov**

Rangelands West Goes International: Introducing *Global Rangelands*

*Barbara Hutchinson**

Recovery of Intermountain Grasslands with Fall Grazing or Rest

*Donald Thompson**

Recruiting Diverse Range Students for the 21st Century

Susan Edinger-Marshall, Lisa Perry*

Redefining Large Carnivore-Livestock Management: A Working Model for Reducing Livestock Conflicts on Public and Private Land in the Mountain West

Timothy Kaminski, Charles Mamo, Joe Englehart, Sarah Dewey*

Reducing Cholla Infestation in SE New Mexico, USA

Braden Johns, Robert Cox*

Regional Economic Implications of Post-CRP Land Use

Dean Bangsund, Larry Leistritz, Nancy Hodur*

Regional Research and Management: Sagebrush Steppe Treatment Evaluation Project

*James McIver**

Regional Research, Demonstration and Extension: The ARS Area-Wide Ecologically Based Invasive Plant Management Project

Brenda Smith, Roger Sheley*

Rehabilitation of Medusahead and Cheatgrass Dominated Rangelands in the Boise Foothills. An Ecologically-Based Invasive Plant Management (EBIPM) Program Research and Demonstration Project

Stuart Hardegree, Jaepil Cho*

Reintroducing Fire into Rangeland Ecosystems: Ecological Adaptations vs. Social Constraints

Samuel Fuhlendorf, Ryan Limb*

Relationships of Fire to North American Grouse

Dwayne Elmore, Samuel Fuhlendorf, Eric Thacker*

Remote Sensing of Plant Community Dynamics in a Sandhills Blowout

Barbara Kagima, James Stubbendieck*

Research and Management Priorities and Strategies for Sustaining Great Basin Ecosystems

*Jeanne Chambers**

Research to Practical Use: On-the-Ground Successes

Charlie Clements, James Young, Dan Harmon, Mark Weltz*

Resource Monitoring Challenges and Technological Needs for the BLM

*Robert Bolton**

Response of Juniper Woodland-Fuel Loading to Mechanical and Prescribed Fire Treatment

Christopher Bernau, Stephen Bunting*

Restoration of Downy Brome Infested Rangelands with Glyphosate and Transplanting Wyoming Big Sagebrush to Increase Diversity

Kent McAdoo, Earl Creech, Chad Boyd*

Restoring Native Plants to Crested Wheatgrass Stands

Jane Mangold, Valerie Fansler*

Restoring Native Tallgrass Prairie and Improving Profitability on Eastern South Dakota Grasslands with Intensive Early Stocking

Kyle Schell, Eric Mouse, Alexander Smart*

Revelations in Lentic Soils: Deciphering System Processes and Resource Conditions from Mud, Muck, and Peat

*Mark A. Gonzalez**

Riparian Forest Regeneration in the Middle Sheyenne River Watershed of North Dakota, USA

Sarah Braaten, Edward (Shawn) DeKeyser, Joseph Zeleznik*

Rodents as Agents of Ecological Change

Kent McAdoo, Bill Longland*

Role of Fire and Grazing in Conserving Grassland and Shrubland Birds in the Southern Great Plains

*Craig Davis**

Sage Grouse Initiative - NRCS, Washington State

*Tim Dring**

Sagebrush (*Artemisia tridentata* ssp *Wyomingensis*) Regeneration 23 Years Following Removal in South Central Wyoming

Michael Smith, Calvin Strom, Diane Fiedler*

Seed Mixes for Diversifying South Texas Rangelands

*Forrest Smith, John Lloyd-Reilley**

Seed Production of Native Plants in the Intermountain West

*Loren St. John**

Seedling Emergence of Diverse Seed Mixes in Post-Wildfire Rangelands

Robert Cox, Nancy Shaw, Mike Pellant*

Seedlings: From Seed to Establishment

Charlie Clements, Dan Harmon, Mark Weltz*

Seeing into Shadows in Resource Monitoring Images

Samuel E. Cox, D. Terrance Booth*

Selecting for Cattle That Enhance Biodiversity in the Sagebrush Steppe

Charles Petersen, Fredrick Provenza, Agee Smith*

Selling Conservation to Get Producer Buy-In

*Justin Meissner**

Selling Conservation to Get Producer Buy-In

*Justin Meissner**

Sentinel Plants: Diagnostic Guides for Adaptive Management

Robert Skinner, Sam Fuhlendorf*

Setting the Bar High: Using Science to Evaluate SGI Conservation Outcomes

Dave Naugle, Tim Griffiths*

Social Sciences and Public Rangelands: Perceptions of Bureau of Land Management Employees and Stakeholders

*Audie Blevins, Katherine Jensen, Stephanie Kane, Neil Rimbey, John Tanaka, David "Tex" Taylor, L. Allen Torell, J.D. Wulforth**

Soil Salinity and CRP in South Dakota

Stan Boltz, Jeff Hemenway*

Spatial Autocorrelation in Modeling with Very-High Resolution Imagery and Alternative Modeling Approaches

*Rick Lawrence**

Spatial Movement of Free-Roaming Cattle (*Bos taurus*) When in Proximity to Wolves (*Canis lupus*)

John Williams, Patrick E. Clark, D. Joseph Chigbrow, Kelly K. Crane, Larry Larson, Douglas E. Johnson*

SRR Ecological Assessment Indicators: Selection and Monitoring Techniques

Michael Smith, John Mitchell*

SRR Legal, Educational and Institutional Assessment Indicators

*Stanley F. Hamilton**

SRR Rangeland Ecosystem Services Assessment Framework

*John Tanaka**

SRR Socio-Economic Assessment Indicators

*John Tanaka**

SRR Sustainable Ranch Management Assessment Project - Concepts, Goals, and Objectives

Stanley F. Hamilton, Dick Loper*

Stable Isotope Diet Reconstruction Using Tail Hairs of Feral Horses on the Sheldon National Wildlife Refuge

Megan Nordquist, Todd Robinson, Steve Petersen, Gail Collins*

Standardized BLM and NRCS Inventory and Monitoring Protocols

Carol Spurrier, Pat Shaver*

Status and Management of Amphibians on Montana Rangelands

*Bryce Maxell**

Stocking Rate Effects on Spatial Heterogeneity in Vegetation Cover in a Grazing-Resistant Grassland

David Augustine, Terrance Booth, Samuel Cox, Justin Derner*

Success Using an Interdisciplinary Approach for Watershed-Scale Land Health Assessments and Subsequent Project Implementation

Pat Fosse, Brian Thrift, Ryan Martin*

Successional Pathways of Wyoming Big Sagebrush Communities Historically Seeded with Crested Wheatgrass

Tom Monaco, Justin Williams*

Survival and Growth of 8 Shrubs Transplanted into Amended Fluvial Mine Tailings

Joe Brummer, Paul Meiman, Natasha Davis*

Survival and Habitat Selection of Ring-Necked Pheasant Broods in Southwest North Dakota

Kristine Larson, Benjamin Geaumont, Christopher Schauer, Kevin Sedivec*

Sustainable Ranch Management through Business Planning and Rangeland Monitoring

John Tanaka, Kristie Maczko, Mike Smith, John E. Mitchell, Cindy Garretson-Weibel, Doug Powell, Chuck Quimby, Gene Fults, Chuck Stanley, Stan Hamilton, Niels Hansen, Dick Loper, J.K. "Rooter" Brite*

Sustainable Rangelands Roundtable (SRR) Overview

Kristie Maczko, John Tanaka, Stanley F. Hamilton*

Tebuthiuron Role in Rangeland Restoration Programs

Robert Masters, Byron Sleugh, Chad Cummings, Greg Alpers, John Jachetta, Vernon Langston*

Ten Year Assessment of a Tebuthiuron Treatment of Shinnery Oak to Enhance Grassland in Eastern New Mexico: What Did We Learn?

*Charles E. Dixon**

Ten-Year Invasive Vegetation Changes on a South Texas Range

Aaron Tjelmeland, J. Alfonso Ortega-S., Jorge Molina, Kevin Porter, Laura Bush, Forrest Smith, Marc Bartoskewitz, Fred C. Bryant*

Texas GLCI - Growing Partnerships in Texas

*Mark Moseley**

The Business Planning Process and Incorporation of Monitoring Information

*Cindy Garretson-Weibel**

The Constant Gardener: Ecosystem Effects of Seed Dispersal by Ungulates

Mary Rowland, Catherine Parks, Martin Vavra*

The DF1 Tip Jet Personal Helicopter: An Innovative Platform for Obtaining Very-High Resolution Aerial Images

*Ricardo Cavalcanti**

The Diversification of Crested Wheatgrass Experience

*Michael Schellenberg**

The Ecological Reserve El Uno - Strategies for Integral Range Management in Short Grass Prairie in the Northwest Chihuahua, Mexico

Pedro Angel Calderón-Domínguez, Carlos Ortega-Ochoa*

The Ecology of Disturbed Ecosystems

*Tom Monaco**

The Ecology of Seedling Establishment on Rangeland

*Jeremy James**

The Economic Consequences of Ecological Thresholds: An Application to Ranching in the Great Basin

*Mimako Kobayashi, Kimberly Rollins, Michael Taylor**

The Effect of Fairy Rings on Soil Aggregation and Rangeland Grasses

TheCan Caesar, Erin Espeland, Anthony Caesar*

The Evaluation of Ring-Necked Pheasant and Duck Production on a Multiple Land Use Management System on Post-Contract Conservation Reserve Program Grasslands

Benjamin Geaumont, Kevin Sedivec, Christopher Schauer*

The Great Basin Landscape Conservation Cooperative: Building on Existing Collaborative Programs

*Mike Pellant**

The Great Basin Native Plant Selection and Increase Project - Linking Research, Management and the Native Seed Industry

Nancy Shaw, Mike Pellant*

The Great Basin Research and Management Partnership: Facilitating Collaborative Solutions

*Stuart Hardegreer**

The Impact of Livestock Grazing at State and National Scales on US Dryland Productivity at 1-km and 8-km Resolution from 1981 to 2009

Robert A. Washington-Allen, R. Wasantha Kulawardhana, Matt C. Reeves, John E. Mitchell*

The Importance of a Long-Term View of Rangeland/Fire Interactions

*Tony Svejcar**

The Importance of Education in Managing Invasive Plant Species

Steve Young, Roger Sheley, Brenda Smith, Larry Howery, Sandra McDonald, Randy Westbrooks, Becky Westbrooks, Erik Lehnhoff*

The Invasion of Smooth Bromegrass and Kentucky Bluegrass in Restored Grasslands as a Function of Species Diversity

Andrew DiAllesandro, Breanna Paradeis, Mario Biondini*

The New Integrated Paradigm for Research, Education and Extension

*James Dobrowolski**

The Power of Personal Stories to Educate

Holly George, jesikah maria ross*

The Rangeland Science Database: A Search Engine for Range Professionals

*Jason Clark**

The Right Conservation in the Right Places: Using Sage-Grouse Core Areas to Target SGI Resources

Dave Naugle, Kevin Doerty, Jason Tack, Jeff Evans*

The Rise and Fall of Western USA's Great Elk Herds

*David Allen**

The Role of Beavers as Agents of Ecological Change: Ecosystem Engineering and Herbivory in Lotic and Riparian Ecosystems

*Stewart Breck**

The Role of Fire in Sustainable Rangeland Ecosystems

Ryan Limb, Samuel Fuhlendorf*

The Role of Relative Size and Nitrogen (N) Availability in Competitive Interactions between Cheatgrass (*Bromus tectorum*) and Bluebunch Wheatgrass (*Pseudoroegneria spicata*)

Noelle Orloff, Jane Mangold, Fabian Menalled, Zach Miller*

The Socioeconomic Impact of Climate Change on Ranching in BC

*Mercedes Cox**

The US Rangeland Base: A Comprehensive Geographic Analysis of the Extent of Coterminous US Rangelands

*Matt Reeves**

The Williamson Cattle Company - Florida Environmental Stewardship Award Winner 2010

Chad George, Brandee Williams*

Thirty-Year Persistence of 17 Plant Species in a Low Precipitation Zone

Mark Stannard, Clarence Kelley, Wayne Crowder*

To Graze or Not to Graze: Managing for Plant Diversity?

Karen Hickman, Ken Belcher*

Tools for Analysis of Very-High Resolution Images

Jason Karl, Terrance Booth, Scott Schrader, Samuel Cox*

Transcending Communication Borders in Range Management

Cristina Francois, Abe Clark, Del Despain, Don McClure, Rob Grumbles*

Understanding Priority Effects May Help Improve Restoration Outcomes and Establishment of *Artemisia tridentata* spp. *wyomingensis*

Kurt Reinhart, Cheryl Murphy*

Understory Cover in Relation to One Seed Juniper Sapling Stand Structure at a Site in New Mexico

Andres Cibils, Terrance Booth, Samuel Cox, Brad Cooper, Richard Dunlap, Shad Cox, David Borland*

Understory Responses to a Mixed-Severity Wildfire in Ponderosa Pine Forests of the Black Hills, USA

Mandi Robertson, Paul Meiman, Frederick Smith, Tara Keyser*

Ungulate Herbivory as a Chronic Disturbance to Ecosystems

Marty Vavra, Bryan Endress, Michael Wisdom, Catherine Parks*

USDA NRCS Conservation Program Financial and Technical Assistance to Support Producers in Conservation, Assessment, and Business Planning

Mark Parson, Dennis Thompson*

USDA-Natural Resources Conservation Service and Prescribed Burning on Non- Federal Lands

*Patrick Shaver**

Use and Effectiveness of VLSA Imagery for Invasive Weed Monitoring in Rangelands

Brian Meador, Dana Blumenthal*

Use of Direct and Indirect Estimates of Crown Dimensions to Predict One Seed Juniper Woody Biomass Yield for Alternative Energy Uses

Santiago Utsumi, Andres Cibils, Brent Racher, David Borland, Terrance Booth, Matthew Bobo, Samuel Cox, Shad Cox, Richard Dunlap, Al Sandoval, Kent Reid*

Use of Monitoring and Business Planning in the Context of Joint Cooperative Monitoring and Federal Grazing Allotments

*Chuck Quimby, Doug Powell**

Use of Seed Agglomeration Technology for Enhancing Seedling Emergence in the Presence of Physical Soil Crust

Matthew Madsen, Kirk Davies, Tony Svejcar, Jason Williams*

Uses and Benefits of Consistent Indicators and Scalable, Integrated Sample Design for BLM Local-to-National Data Needs

Gordon Toevs, Jason Karl, Jason Taylor, Matthew Bobo, Jeffrey Herrick, Carrol Spurrier, Craig Mackinnon*

Using Cattle Supplementation to Enhance Range Wetland Condition

*Tara Luna, Robert Welling**

Using Ecological Site Descriptions to Guide Sage Grouse Conservation

Wendell Gilgert, Pat Shaver*

Using Images to Evaluate the Relationship Between Habitat Characteristics and Sage-Grouse Lek Counts

Jeffrey Beck, D. Terrance Booth*

Using Low-Stress, Pressure-and-Release Tactics and Attractants to Move Producers to a Better Place in the NRCS

Tim Steffens, Sarah Hanlon, Joel Moffett, Michael Casper, Ed Kilpatrick, Tom Werner*

Using Plant Functional Groups to Create Data-Driven State-and-Transition Models

Emily Kachergis, Maria Fernandez-Gimenez, Monique Rocca*

Using Similarity Indices as a Tool for Characterizing and Monitoring Vegetation within Prairie Dog Colonies in Southwestern South Dakota

Eric Boyda, Jack Butler, Lan Xu*

Using Small Unmanned Aerial Systems to Collect High Resolution Imagery for Site Specific Land Management Applications

*Thomas Zajkowski**

Using Social Media (BLOGS, Facebook, & Twitter) for Extending Range Livestock Information

*John Harper**

Using the ¹⁵N Natural Abundance Method to Determine N₂-fixation in Russet Buffaloberry in Colorado

Zoe Miller, Mark Paschke*

Using the Environmental Quality Incentives Program to Address Rangeland Drought and Grazing Land Management in South Dakota

Mitch Faulkner, Shane Deranleau, Stan Boltz*

Using the Sage-Grouse Initiative, Conservation Easements, and State Regulations to Address Threats to Sage-Grouse Habitat in Wyoming

Gerald Jasmer, Thomas Christiansen*

Using VHR Imagery for Rangeland Monitoring and Assessment: Some Statistical Considerations

Jason Karl, Jean Opsomer, Sarah Nusser, Andrea Laliberte, Michael Duniway, Robert Unnasch*

Variability in Light-Use Efficiency for Gross Primary Productivity on Great Plains Grasslands

Wayne Polley, Rebecca Phillips, Albert Frank, James Bradford, Phillip Sims, Jack Morgan, James Kiniry*

Variation among SamplePoint Users with Respect to Shadows and Other Variables

Amanda L. Gearhart, Christopher S. Schauer, D. Terrance Booth, Kevin K. Sedivec*

Variation in Plasma Metabolic Indicators of Mule Deer Does on a Low Quality Winter Diet on the North Kaibab Plateau of Arizona

Matthew Acton, William Miller, Ann Steffler*

Vegetation Structure and Composition at Greater Prairie-Chicken Nest and Brood Sites: Drivers for Success?

Lars Anderson, Walter Schacht, Larkin Powell, Jeffery Lusk*

Vegetative Variation between Nesting and Winter Habitat of the Greater Sage-Grouse

*Cheryl Mandich**

Very-High Resolution Image Registration and Mosaic Creation

*James Carr**

Very-High Resolution Imaging for Resources Monitoring

*D. Terrance Booth**

Water Requirements of Common Plant Species in the Owens Valley, CA

Tracie Evans, Ricardo Mata-Gonzalez, David Martin, Terry McLendon*

Watershed Restoration Committee for the Upper Clark Fork River

*John Hollenback**

"Wealthy Rancher" Calculator

*Arnold Mattson**

Weather and Climate Applications for Rangeland Restoration Planning

Jaepil Cho, Stuart Hardegree, Jeanne Schneider*

Weather or Not: Changes in Grazed and Ungrazed Great Plains Grassland Plant Communities Associated with Interannual Variability in Weather

Jayne Jonas, Amy Symstad, Deborah Buhl*

Weed and Brush Management in Pasture and Rangeland with Aminocyclopyrachlor

James Harbour, Jeff Meredith, Eric Castner, Michael Edwards, Susan Rick, Craig Alford*

Wetland Resources and Issues in the Prairie Pothole Region of the Northern Great Plains

*Shawn DeKeyser**

What Makes for Effective Collaboration?

*Nat Frazer**

Wildfire as a Process in Riparian Recovery and Stability

*Clayton B. Marlow**

Will Super Juniper-Eating Sires Produce Super Juniper-Eating Offspring?

Kendall Tidwell, Cody Scott, Charles Taylor, John Walker, Dan Waldron, Corey Owens, Micheal Salisbury*

Wolf Damage Management in Minnesota

*John Hart**

Wolf Diets and Depredation Patterns in Southwestern Alberta

*Andrea Morehouse**

Wolf Management in Alberta, Canada

*Mark Boyce**

Wolf Recovery: An Independent Analysis

*Charles E. Kay**

Wolf Reintroduction: A Montana Perspective

*Jaala Wickman**

Wolves & The Natural Law

*Jim Beers**

Wolves on the Landscape

*Kevin France**

Woody Plant Encroachment Following Fire Suppression in the Kansas Flint Hills

*Thomas Bragg**

Working with California and Nevada Ranchers in a Coordinated Effort to Recover the Sage Grouse

*Tom Moore**

Working with Private Landowners to Recover Sage Grouse Habitat and Improve Ranching Sustainability in Nevada

*Jamie Jasmine**

Working with Private Landowners to Recover Sage-Grouse Habitat and Improve Ranching Sustainability

*Peter Husby**

Yield Response of Summer-Dormant and -Active Tall Fescue to Stockpiling

James Rogers, Carolyn Young, Jagadeesh Mosali, Shawn Norton*

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0001

Wolf Management in Alberta, Canada

Mark Boyce

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Gray wolf (*Canis lupus*) populations are recovering in many parts of the world and managers from various jurisdictions will be faced with difficult decisions as wolf populations continue to increase. Wolf management in Alberta is achieved mostly through trapping on a registered trapline system. Wolf harvest increased over the last 22 years relative to population increases. Most wolf harvests occurred in the Rocky Mountains and surrounding foothills area and this pattern was consistent over time. On average, trappers harvested <10% of the provincial population annually despite the lack of bag limits or quotas. Harvests are spatially autocorrelated with peak autocorrelation coinciding with average home-range size for wolves in Alberta. When wolf control actions are deemed necessary, trappers are unlikely to remove a sufficient number of wolves over a large enough area to limit subpopulations under the registered trapline system.

0002

Wolf Diets and Depredation Patterns in Southwestern Alberta

Andrea Morehouse

University of Alberta, Edmonton, Alberta, Canada

The sharp interface between mountains and prairies in southwest Alberta means wildlife habitats overlap prime cattle grazing lands. Consequently, a number of stakeholder groups are concerned over wolf (*Canis lupus*) depredation on livestock. Producers are compensated for confirmed losses to predators, but missing cattle remain a persistent problem. Such conflicts often result in the removal of these predators. A lack of information about wolf diets and activity in this multi-use landscape makes management decisions more difficult. To assess the impact of wolves on cattle we collared wolves with GPS radiocollars programmed on a 1-hr duty cycle and analyzed these data for clusters of activity. Year-round field visits of 698 cluster sites revealed 213 kill or scavenge sites. Wolf diets shifted dramatically from livestock during the grazing season to wild prey in the winter months, but cattle depredation remained a year-round problem. We used kill-site locations, cattle stocking densities and age class, and spatial layers in a GIS framework to estimate resource selection functions (RSF) and maps of these RSFs highlighted areas of highest relative risk of wolf depredation. These "hotspot" maps represent an important management tool in narrowing the areas of focus for wolf-livestock mitigation efforts, especially in the grazing areas of the public forest reserve.

0003

Wolf Damage Management in Minnesota

John Hart

USDA-APHIS-Wildlife Services, Grand Rapids, Minnesota, United States

The USDA-Wildlife Services (WS) wolf depredation management program based in Grand Rapids, Minnesota uses a variety of methods to manage wolf damage. Wolves in Minnesota regularly kill livestock (cattle, sheep, poultry and occasionally horses) and pets, primarily dogs. While the magnitude of damage is relatively small (1-2% of farms in wolf range), the losses to individual producers can be significant. Minnesota wolves have expanded both their population and range in recent decades from heavily forested and remote areas of extreme northern Minnesota into more agricultural and even sometimes urban areas throughout northern and central Minnesota. Current estimates are of approximately 3,000 wolves in Minnesota. This increase in wolf numbers and proximity to people has caused an increase in wolf/human conflicts. WS investigates claims of wolf damage to livestock and pets in cooperation with the Minnesota DNR. If damage is verified and there are opportunities for future losses, WS may initiate wolf removal efforts near the depredation site to reduce the likelihood of additional damage. WS also uses non-lethal methods and technical assistance to reduce wolf damage where appropriate. In addition to resolving individual depredation situations, the WS program helps to define the extent of wolf depredations in Minnesota, provides accurate information to livestock producers, resource managers and other interested parties, and ultimately has assisted with wolf recovery in Minnesota by providing a buffer between wolves and those experiencing wolf damage.

0004

Functional Traits and Their Use in Plant Improvement

Jeremy James¹, Tom Jones²

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Sustainable land management requires an understanding of how plant community composition impacts ecosystem properties such as invasion resistance. Research has largely focused on the relationship between species or functional group diversity and ecosystem properties. However, it is becoming increasingly clear that species and functional group diversity are relatively poor predictors of plant community effects on ecosystem properties. Plant functional traits, which include the physiological, morphological and life history traits that determine how a plant affects and responds to the environment may be better predictors of plant community effects on ecosystem properties. Here we discuss what suite of plant traits have the greatest potential to guide plant improvement efforts for rangeland restoration using a case study of 17 *Elymus elymoides* (native perennial grass) and 13 and 10 *Taeniatherum caput-medusae* (invasive annual grass) accessions collected from native and introduced ranges, respectively. Using path analysis we evaluated how variation in a suite of germination, root growth, shoot growth and nitrogen use efficiency traits contributed to variation in fitness. Early germination, root growth at low temperature and high specific leaf area were important traits influencing variation in fitness. There was substantial variability among accessions within a species and in some cases native plant populations had trait values similar to the invader. Understanding what traits contribute most to variation in fitness can help guide future plant improvement efforts and may allow managers to strategically select plant materials most appropriate for a particular restoration scenario.

0005

Grass Seedling Demography in the Great Basin: Implications for Restoration

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¹USDA-ARS, Burns, OR, United States, ²USDA-ARS, Miles City, MT, United States

Recruitment often is a central limitation to plant community restoration. Seeding native species is a critical tool that allows managers to overcome these limitations and positively influence plant community assembly. However, seeding is a high-risk and expensive practice in arid systems where interannual variation in environmental conditions can lead to large year-to-year variation in recruitment success. Here we examine the demography of seeded grass species to determine what critical life stages may be central drivers of seeding failures and to identify management opportunities to improve establishment. We measured life stage transition probabilities spanning germination to 1 year survival for three years on three grass species as well as transition probabilities following seeding of four fire complexes. Across years, the largest bottleneck for native species was the transition between germination and emergence but this was not necessarily true for the introduced crested wheatgrass. Across the fire complexes the transition between germination and emergence was less than 0.1, representing a clear bottle neck to recruitment. We discuss how these results may be used to ultimately improve rangeland restoration outcomes.

0006

Managing Fire and Fuels in the Northeast Mojave Desert: The Mojave Desert Initiative

Scott Florence

US Bureau of Land Management, St George, Utah, United States

The Mojave Desert Initiative (MDI) was established in 2007 as a forum for government agencies and other partners to collaboratively address wildfire and invasive species issues within the NE Mojave Desert in Arizona, Nevada, and Utah. This presentation will review the process used to identify strategic goals and actions for the MDI. The major goals of the MDI are to protect remaining unburned habitats and restore strategically located islands, key habitat areas, and corridors. Major actions include the development of regional guidance for fire personnel to minimize further loss of habitat and a regional assessment used to identify priority areas of work and project ranking/selection criteria. The presentation will review the types of projects being planned and implemented throughout the region, including strategies to adapt to changing conditions.

0007

Controlling Japanese Brome with Grazing Management in Judith Basin County, Montana

Rick Caquelin

USDA-NRCS, Stanford, MT, United States

The Porter Ranch in northeast Judith Basin County, Montana began rangeland photo monitoring in 2007. A pasture with a severe Japanese brome infestation was chosen for one monitoring location. A grazing prescription was designed to reduce the Japanese brome density while improving the density and production of the native grasses. Annual photo monitoring and grazing records were completed in 2008 and 2009 to document the effect of the grazing treatments. With careful management Japanese brome growth was substantially reduced resulting in an equal increase in native grass production.

0008

Home Range, Habitat Selection, and Survival of Greater Roadrunners

Dean Ransom, Jr.

Rolling Plains Quail Research Ranch, Texas Agrilife Research and Extension Center, San Angelo, TX 76901, United States

The Greater Roadrunner (*Geococcyx californianus*) is a common bird of arid and semi-arid rangelands in the southwestern U.S. Conservation of this cursorial avian predator requires detailed understanding of movements and spatial requirements which are currently lacking, especially in light of habitat fragmentation due to human development. We describe home-range and core area sizes, overlap, and survival of 34 roadrunners (14 M, 20 F) captured in north-central Texas using radio-telemetry and fixed kernel estimators. Roadrunner home ranges were large and highly variable, with median home-range and core area sizes of 90.4 ha and 19.2 ha for males and 80.1 ha and 16.7 ha for females, respectively. Home range overlap occurred most frequently between male:female dyads, but male:male dyads displayed the highest magnitude of overlap. Male roadrunners selected mesquite woodlands and mesquite savanna habitat types and avoided grass/forb habitat types; females selected for mesquite savanna and riparian woodland habitats. Annual survival for females (0.451 ± 0.118) was twice that of males (0.210 ± 0.108); the highest period of mortality for males was during the spring and early summer.

0009

Estimating Prickly Pear (*Opuntia*) Pad Density by Line Intercept, Belt Transect, and Quadrat Methods

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Prickly pear cactus (*Opuntia* spp.) occurs on approximately 12.5 million ha of rangelands inhabited by wildlife and livestock in the western two-thirds of Texas. While prickly pear has value for wildlife, it decreases forage production for cattle and thus often targeted for control with herbicides and prescribed fire. Common techniques of determining absolute density of prickly pear for evaluating control measures can be time consuming and often logistically prohibitive. We evaluated utility and efficiency of the line intercept method as an index of relative abundance in comparison to two methods (1 m² quadrats, 100 m² belt transects) for estimating prickly pear absolute density in reverted cropland and native rangeland. Regression analyses of prickly pear density for all pair-wise comparisons were statistically significant. Most importantly, relative density determined by line intercept method was significantly correlated with absolute density determined by belt transect (rangeland: $r^2 = 0.9879$, $df=70$, $P<0.001$; reverted cropland: $r^2=0.9515$, $df=25$, $P<0.001$) and by the quadrat method (rangeland: $r^2 = 0.985$, $df=70$, $P<0.001$; reverted cropland: $r^2 = 0.9274$, $df = 25$, $P<0.001$). Standardized residual plots on fitted values indicate that the variance of the regression line tended to increase slightly with increasing values of the independent variable; the only exception was the comparison involving the quadrat and line intercept method. The belt transect method took 3x longer to complete than the line intercept method. Our data suggest that the line intercept may be a useful and efficient index for estimating prickly pear density.

0010

Comparing Two Ground-Cover Measurement Methodologies for Semiarid Rangelands

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The limited field-of-view (FOV) associated with single-resolution very-large scale aerial (VLSA) imagery requires users to balance FOV and resolution needs. This balance varies by the specific questions being asked of the data. Here, we tested a FOV-resolution question by comparing ground-cover measured in the field using point-intercept transects with similar data measured from 50 millimeters per pixel (mmpp) VLSA imagery of the same locations. Particular care was given to spatial control of ground and aerial sample points from which observations were made, yet percent cover estimates were very different between methods. An error budget was used to calculate error of location and error of quantification. Budget results indicated location error (0.435) played a substantial role, compared with quantification error (0.216); however, significant quantification error was present. We conclude that: 1) while the georectification accuracy achieved in this project was actually quite good, the level of accuracy required to match ground and aerial sample points represents an unrealistic expectation with currently available positioning technologies, 2) 50 mmpp VLSA imagery is not adequate for accurate ground-cover measurement, and 3) the balance between resolution and FOV needs is best addressed by using multiple cameras to simultaneously acquire nested imagery at two or three VLSA resolutions. We recommend ground-cover be measured from 1-mmpp imagery and that the imagery be nested in lower resolution, larger FOV images simultaneously acquired.

0011

Owl Mountain Partnership

Peter Torma

BLM, Kremmling, CO, United States

In 1993 the Owl Mountain Partnership was formed and became one of the first community-based collaborative efforts to demonstrate the value of applying sound ecosystem-based management principles within the North Platte River Basin in Jackson County, Colorado. The mission has been to serve the economic, cultural and social needs of the community while developing adaptive long-term landscape management programs and practices that ensure land-health. Today, the Owl Mountain Partnership boundaries have expanded to include other counties. This diverse partnership is composed of members from the local livestock community, private landowners, interested public, and federal, state and local natural resource management agencies and organizations. They have successfully created a partnership that has built trust and citizen stewardship to improve resource conditions within North Park that has lasted 17 years. Through hard work and support of various organizations, the OMP has spent over \$1,000,000 on projects to benefit wildlife habitat for such species as elk, sage-grouse, waterfowl and mule deer while helping to sustain our local economy which is directly connected to the land. In addition to implementing projects, we have acted as the facilitator for numerous livestock grazing management systems. The largest plan encompassed over 125,000 acres of private, state and federal lands.

0012

Interagency Creeks and Communities Strategy

Laura Van Riper

National Riparian Service Team, Bureau of Land Management, Prineville, OR, United States

Riparian-wetland areas provide communities with a variety of ecological, economic and social benefits even though they comprise a relatively small percentage of the total land base. Today, it is well known that the successful management of these areas is dependent upon bringing diverse groups of people together and building the capacity needed to confront and manage complex and contentious issues. The interagency *Creeks and Communities Strategy* is designed to integrate the bio-physical and social dimensions of riparian-wetland management in order to achieve results that benefit both creeks and the communities that depend on them. This strategy, originally developed in 1996, works to build ownership and commitment in those individuals who must accept and often voluntarily implement management decisions by incorporating scientific and technical information into collaborative decision-making processes. The objective of this presentation is to: 1) describe the interagency strategy and the approaches and tools used to achieve its goal, and 2) to showcase the Upper Missouri River Breaks National Monument's use of the *Creeks and Communities* strategy as a means to bring diverse and conflicting stakeholders together to build relationships, increase understanding of riparian-wetland function and maintain or enhance riparian-wetland conditions within the Monument.

0013

Changes of Some Elements in Three Species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of Enclosure in Two Seasons (Summer and Autumn) in Rude Shur Saveh Rangelands

maryam saffariha, hosein Azarnivand, ali tavili
Tehran University, Tehran, Iran, Islamic Republic of

This study compared changes of some elements in three species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of enclosure in two seasons (summer and autumn) in Rude Shur Saveh rangelands. Two transects with length of 300 m were placed within the enclosure and two transects with the same length were placed outside. 10 one meter square plots were collected along each transect. Aerial and under ground tissues of three species were sampled two times during the year (summer and autumn) only in plot numbers 1, 5 and 10 (three out of ten plots along each transect). For plant chemical properties, included N, P, K, Ca, Mg, Na, and C., ANOVA and Duncan test were made for data analysis. The results indicate that quantity of carbon, Ca, Mg, Na and K were higher outside the enclosure in autumn while the amount of P and N higher within the enclosure in summer.

0014

Changes of Some Elements in Soil of Three Species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of Enclosure in Rude Shur Saveh Rangelands

maryam saffariha, hosein Azarnivand, ali tavili
Tehran University, Tehran, Iran, Islamic Republic of

This study compared changes of some elements in the soil associated with three species of *Artemisia sieberi*, *Salsola rigida*, and *Stipa barbata* within and out of enclosure in Rude Shur Saveh rangelands. Two transects with length of 300 m were placed within the enclosure and two transects with the same length were placed outside. 10 one meter square plots were collected along each transect. Soil sampling was performed from depths 0-30 and 30-60 cm in plot numbers 1, 5 and 10 (three out of ten plots along each transect). The following properties of soil were determined; texture, lime, gypsum, pH, EC, OM, N, P and K. ANOVA and Duncan test were made for data analysis. The amount of soil P outside the enclosure was higher compared to inside. pH and all other elements tested did not show differences between inside and outside of the enclosure.

0015

Bureau of Land Management, Wyoming - High Desert District, Rawlins Field Office, Sulphur Springs Allotment

Andy Warren

BLM-WY-HDD-Rawlins Field Office, Rawlins, Wyoming, United States

The Sulphur Springs Allotment was originally explored by Jim Bridger and developed into an overnight stop along the Overland Trail in the 1860s. Homesteading and ranching have occurred since then, with a single unit put together by the Enberg-Sanger Family in the 1940s. This allotment of approximately 23,000 acres (53% public land) became one of the first allotment management plans (AMP) developed by the BLM in 1968 with an emphasis on upland management. A revision of the AMP in 1988 focused more on riparian management, as this allotment is located in the Upper Muddy Creek watershed which contains the headwaters of Muddy Creek, Littlefield Creek and McKinney Creek. Through the years, pasture fencing, upland water developments, prescribed burns, road improvements, gradient control and riparian plantings have been implemented. An early emphasis on the reintroduction of Colorado River Cutthroat Trout has expanded into warm-water fish management of roundtail chub, bluehead and flannelmouth sucker, and removal of competing non-native fish species. Monitoring includes 3x3 plots and pace-frequency transects in the uplands, along with photo-points, channel cross sections, macro-invertebrate and water quality sampling, and fisheries research. These efforts were only possible by developing strong partnerships, and by consultation, cooperation, and coordination. Parties involved besides BLM and Sanger Family include: Little Snake River and Saratoga-Encampment-Rawlins Conservation Districts, WGFD, NRCS, University of Wyoming Extension Service, WDEQ, and Trout Unlimited. The history of the Sulphur Springs Allotment is not only about changes in livestock management, but the broader look from a landscape and watershed perspective involving all resource values.

0016

"Wealthy Rancher" Calculator

Arnold Mattson

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Grasses/forages are one of the least understood crops in terms of their sustainable economic value, and goods and services they contribute to human well-being. Grasslands are the foundation to our livestock industry and should not be taken for granted. If not corrected this lack of understanding will continue to threaten the long-term economic and ecological contributions of these indigenous grasslands. An economic assessment of a grazing system provides a manager with an enterprise plan that is profit driven rather than production driven. The intent is to show net profit for the use of the land, the grass production and the livestock. The starting point is to assess each enterprises basic unit cost, returns at a reasonable market value, and resulting profit. With the "Wealthy Rancher" calculator all you have to do is click on which enterprise (yearling or cow-calf) you want to work on and then enter your production figures in the yellow area and the calculator will do the rest. The calculator divides your ranch into profit centres, land, pasture, livestock, and gives you an estimated return for each. It will show what return you can expect from each enterprise. Whether you are a landowner, a custom grazer, or a livestock producer, allocating your own figures (expenses as well as revenues) in this manner can help you assess the financial situation of any segment of your business. Just let the "Wealthy Rancher" calculator do the work for you.

0017

Increasing Native Plant Diversity in Crested Wheatgrass Stands: Theory, Practice and Problems

Val Anderson

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Restoring native plant diversity to rangelands dominated by exotic annual weeds is a goal of land managers. One approach may be to combine the earlier strategy of reclamation using crested wheatgrass, with a subsequent infusion with native plant species. Crested wheatgrass has been successfully established over millions of acres throughout the West and has demonstrated the ability to competitively exclude invasive annuals to their near extirpation on a site. Unfortunately, near pure stands of crested wheatgrass are subject to insect invasions and are limited in their value for biodiversity of other organisms. On western rangelands, the recapture of a site with crested wheatgrass from annual plant domination represents a shift back to a perennial ecology of resource utilization and fire frequency. Using crested wheatgrass as a surrogate for early colonizers creates a fire resistant vegetative cover that can suppress annuals, unfortunately, it also provides resistance to the recovery of native perennials. Established stands of crested wheatgrass would have to be significantly disrupted to open niches for the insertion of native species. This disruption can most effectively be achieved through the use of mechanical or herbicide treatments. Theoretically, niche opening treatments are designed to weaken existing stand's hold on site resources by reducing density and health of these plants while facilitating establishment of seeded native species. Two primary questions must be addressed: 1) can crested wheatgrass stands be sufficiently suppressed to allow insertion and establishment of the native species, and 2) does niche opening expose sites to reinvasion by annual weeds.

0018

Cheatgrass Invasion Increases Wildfire Frequency and Size by Altering Fuel Characteristics

Kirk Davies

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Cheatgrass is an exotic annual grass invading millions of acres in the western United States. Invasion by cheatgrass is especially problematic because it can increase wildfire frequency to the detriment of native plant communities. Fine fuel characteristic of cheatgrass-invaded plant communities differ from native plant communities in several aspects that simultaneously promote more frequent and larger wildfires. Fine fuel accumulations are often greater in cheatgrass-invaded compared to native plant communities. Concurrently, fine fuel continuity is greater in cheatgrass-dominated compared to native plant communities. More continuous fuels and increased fuel accumulations increase the probability a plant community will burn and risk of large fires with little unburned patches in the burn. Cheatgrass also dries out before most native grasses which elongates the wildfire season because fine fuels are dry enough to burn earlier in the growing season. Early season wildfires are also especially detrimental to actively growing native vegetation and this promotes the expansion of cheatgrass. Native plant communities in close proximity to cheatgrass invaded plant communities are at an elevated risk of burning because of fires that originate in the cheatgrass communities. Alterations to the fine fuel characteristics with cheatgrass invasion promote its continued dominance of invaded plant communities and its spread into other plant communities. Management to prevent the continued expansion of cheatgrass and restore cheatgrass-invaded communities needs to focus on altering these fuel characteristics.

0019

Wolf Recovery: An Independent Analysis

Charles E. Kay

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Dr. Kay will discuss various aspects of wolf recovery including - -Do wolves and other predators limit ungulate populations to levels much lower than the habitat would otherwise support? Do wolves and other predators reduce and/or eliminate hunting opportunities? What are the true costs of livestock depredations? Do wolves only kill the young, the sick, or the infirm? Are wolves keystone predators that are needed to "balance" ecosystems? Dr. Kay will also explain how the federal government has set-up the various delisting lawsuits to lose and why delisting itself is a hollow goal. And finally, Dr. Kay will explain why wolf recovery has actually very little to do with wolves and virtually nothing to do with science. Instead, the entire process has been and is being driven by larger political agendas including views of nature that are romantic, religious, and racist.

0020

Preserving CRP Grassland Benefits in Western Nebraska

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The US Department of Agriculture's Conservation Reserve Program (CRP) has been highly successful in western Nebraska with 382,000 acres enrolled. These grassland acres provide critical habitat for wildlife, prevent soil erosion, improve soil health, prevent air and water pollution, and play a role in sequestering carbon. Western Nebraska's CRP grasslands and their invaluable conservation measures are in jeopardy. Between 2009 and 2011, thousands of acres will expire. Due to uncertainty of re-enrollment, producers are faced with hard decisions for their land and operations, which have widespread implications for natural resources. Options include converting their CRP to cropland, or to maintain their lands in grass and implement a grazing system. This project's goal is to maintain CRP's environmental benefits by providing producers with options to maintain acres in grassland for livestock grazing. The project partners (including local, state, and federal conservation agencies) are assisting by providing cost-share assistance for installing facilitating practices to implement a prescribed grazing system on expired CRP, and by providing information and education on the importance of CRP grasslands and their conservation value.

0021

Potential Use of Molecular Markers for Development of Native Plants

Steven Larson

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Utilization of native plants for large-scale rangeland revegetation and fire rehabilitation will be facilitated by a readily available supply of high quality seed at a low cost. However, plant breeders and land managers are also concerned to know if the adaptation and genetic identity of native plant cultivars is compatible with the local environment and wild plant populations. Molecular genetic markers can be used to determine the nature of natural genetic variation across the landscape. This information can be used to select and develop native plant cultivars with superior seed production and also capture and reflect natural genetic diversity across the landscape.

0022

Federal Agencies and Ranchers Working Together - Keys to a Successful Partnership

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The Ely, Nevada BLM District is located in east-central Nevada. It administers approximately 11.5 million acres of public lands. Vegetation ranges from higher elevation Pinyon-Juniper/Mountain Big Sagebrush communities in the northern half of the district to Mojave Desert shrub communities in the southern half. Some of the major livestock management issues that we face in this district are limited water sources, the lack of fences, high sagebrush composition and a low herbaceous composition, Pinyon-Juniper encroachment in the valleys and lower benches, and a high number of wild horses. Range Improvement projects are ongoing throughout the district to improve wildlife habitat, rangeland health and livestock management. Gracian Uhalde and Co., a third-generation Nevada ranching family, manage a successful cow-calf, and sheep operation that provides for the long-term sustainability of private and public lands in eastern Nevada. The operation is permitted on about 422,000 acres of BLM-administered public lands as well as holding a Forest Service permit. They have been a key partner with the Ely BLM in accomplishing some of our goals. Gracian Uhalde and Co. has contributed labor, materials and funding on a number of projects on thousands of acres ranging from fencing and developing water, to reducing Pinyon-Juniper and mowing brush. Some of the keys to a successful partnership has been a willingness for both the BLM and the operator to be flexible with the livestock operations, actively participating in livestock/range management, and to contribute time and resources to improvement projects and maintaining a professional trust.

0023

Ranch-Level Economic Impacts of Predation in a Range Livestock System

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Predation can impose significant costs on agricultural producers in range livestock systems. In this paper we use a multi-year linear programming framework to evaluate the economic effects of predation on a model ranch. In addition to a base scenario, we develop three other scenarios to capture potential predation impacts: increased death loss of calves, reduced calf weaning weights, and increased variable cost. The results suggest predation can have significant impacts on short-term profitability and long-term viability; however, impacts are highly sensitive to the scenario considered. Of the three scenarios, increased variable costs had the least effect on ranch profits. Increased death loss takes a larger toll on profits because it erodes the ranch's core profit center, calf sales. Reduced weaning weights, however, had the largest effect on profits. This is likely occurs because our model assumes that all calves experience lower weaning weight as a result of predator pressure. That is, unlike death loss, where calves are still profitable and only quantity is reduced, reduced weaning weight makes all calves less profitable. Furthermore, as in the death loss scenario, fixed costs remain the same and must therefore be absorbed by calves that generate lower revenues. Our model suggests that high levels of predation can threaten the long-term viability of western ranches. The viability of these ranches is an important public policy concern due to the many ecosystem services they provide. The relationship between predation, ranch viability, and the ecosystem services ranches provide may justify public spending on predator control.

0024

The Importance of a Long-Term View of Rangeland/Fire Interactions

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The impacts of fire on rangelands vary over time. I will cite three published cases where time is important in interpreting fire effects. The first example involves a short-term fire response which may persist for a few years following a fire. Cheatgrass in the Great Basin serves as an example. In many cases the release of nitrogen following a fire can stimulate cheatgrass for several years, a result which may or may not persist. My second case involves the impact of management and weather preceding a fire. An example is a recent study at the Northern Great Basin Experimental Range, where 60 years of management history was necessary to interpret the results of burning. And third, there are situations where conditions (weather or management) during the years immediately following a fire can impact vegetation trends for years to come. Big sagebrush seed is thought to be short-lived (2-3 years), does not disperse far, and mature plants are killed by fire. The weather several years following a fire will have a large impact on sagebrush recolonization of a site. A study conducted in one set of years may yield very different results than the same study at another time. I've cited three specific examples where we might misinterpret the effects of fire by viewing too short a timeframe: 1) there is a transient response to fire, 2) conditions prior to the fire impacted the eventual outcome, and 3) conditions immediately after the fire influences vegetation trajectory.

0025

Arguments for a Major Research Focus on Seedling Establishment and Recruitment on Rangelands

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Understanding vegetation change is the basis for much of the rangeland management profession. Yet we know little about seedling ecology, from the standpoint of either reseeding or natural recruitment. We often view vegetation over long time horizons to allow changes to manifest themselves. If we lack long-term observational data, it is often difficult to make predictions about vegetation trends based on population dynamics. Birth and death rates are used to model plant populations, just as they are with animal populations, but in general we know little about these variables for most rangeland plants. Our limited understanding of the factors controlling seedling establishment (and long term survival) makes it difficult to predict: 1) the probability of seeding and restoration success, 2) the influence of management on vegetation trends, 3) the impacts of invasive species management, and 4) the effects of climatic or resource shifts on vegetation patterns. A comprehensive research effort in this area will require studies of: 1) life history analysis (from seed to adulthood) of both desirable and undesirable species, 2) biotic and abiotic factors which influence survival (at different live stages), 3) weather and soil surface conditions during the establishment phase, and 4) management efforts which will help overcome the limitations to establishment. One caveat is that vegetative reproduction dominates some rangeland and riparian systems and in those cases the suggested research approach would have to be modified. The suggested research will help improve allocation of human and financial resources in rangeland reseeding and restoration projects.

0026

Mapping Leafy Spurge Density in Madison Country, Montana, with Hyper-Spectral-Spatial-Temporal Imagery

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Leafy spurge, a designated noxious weed that has infested large amounts of land in the Northern Great Plains states, is difficult to control and monitor. Development of an affordable technique to map and monitor leafy spurge would contribute to the control of this aggressive species. High spatial, spectral, and temporal imagery from a low-cost sensor was analyzed to detect and classify the amount of leafy spurge present on an unmanaged range site. Aerial hyperspectral images were acquired with 0.3-m ground resolution approximately every 10 days during the summer of 2009, and 50 2-m x 2-m reference areas were surveyed for percent cover of leafy spurge as well as several other variables. Single and multiple date classifications were performed using the random forest classifier. Leafy spurge was most accurately detected early and late in the growing season. Significant classification accuracy increases were observed with the multiple date classification. Single date accuracies achieved 90% overall accuracy in early June, while multiple date classifications achieved over 96% overall accuracy.

0027

Spatial Autocorrelation in Modeling with Very-High Resolution Imagery and Alternative Modeling Approaches

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Mapping estimates of biophysical parameters, such as biomass or weed densities, with remotely sensed imagery is most commonly accomplished using parametric models, such as ordinary least squares regression. These models can have a variety of assumptions, including independent distribution of errors. Spatial data used in these models often violate this assumption, because model residuals can be spatially autocorrelated. Very-high resolution imagery potentially can be more prone to spatially autocorrelated residuals, especially when accompanied by intensive sampling. Diagnostic tools, such as semivariograms, can be used to determine the presence of spatial autocorrelation. Alternatives that do not assume independent distribution of errors can provide appropriate models in such cases. Two such approaches that have been used effectively with remotely sensed imagery are generalized least squares and regression tree-based models. Regression-tree based models include single regression trees and a variety of boosted and bagged regression tree approaches.

0028

Seed Mixes for Diversifying South Texas Rangelands

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Land use practices of the last century dramatically changed south Texas rangelands from their pre-settlement state. Severe overgrazing, unsavory oil and gas production practices, and the purposeful planting and uncontrollable spread of exotic forage grasses all contributed to this change. In the past two decades, increased emphasis on managing south Texas rangelands to maximize economic and recreational potential of wildlife-related activities has influenced land managers to desire to restore rangelands to a state dominated by native plants. Prior to 2001, no ecotypic native seed was available for use by restorationists to attempt restoration seeding. A collaborative effort known as South Texas Natives was begun in 2001 by the Caesar Kleberg Wildlife Research Institute and the USDA NRCS E. "Kika" de la Garza Plant Materials Center to develop native seed sources for the region, and coordinate research to develop effective restoration strategies. Plant development efforts focus on providing intra-species diverse seed releases from a number of plant functional groups that are commercially feasible to mass produce at reasonable cost to consumers. More than 50 species of native plants have been evaluated resulting in 13 seed releases, including cool and warm season annual forbs, perennial forbs, early successional perennial grasses, and dominant perennial grasses. Success rates of field plantings using mixtures of these releases have exceeded 75%. Numerous other species continue to be evaluated, eventually resulting in additional releases to further meet the need for high diversity native seed mixes for use on south Texas rangelands.

0030

The Great Basin Research and Management Partnership: Facilitating Collaborative Solutions

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The Great Basin is undergoing major sociological and ecological change as a result of urbanization, changing technology and land use, climate change, limited water resources, altered fire regimes, and invasive species, insects, and disease. Sustaining ecosystems, resources, and human populations of the Great Basin will require strong collaborative partnerships among research and management organizations in the region. In November, 2006, a workshop was held in Reno, NV on the topic of "Collaborative Watershed Management and Research in the Great Basin". A principal outcome of the workshop was the recommendation to develop an organizational framework: to identify and prioritize regional issues, expand and support existing collaborations, facilitate new teams to address emerging issues, and promote information sharing among programs and people. This ultimately resulted in the development of a MOU to form the Great Basin Research and Management Partnership which is described in more detail on the GBRMP website: (<http://greatbasin.wr.usgs.gov/GBRMP/index.html>). The website also serves as an information clearinghouse for Great Basin research and management activities and currently includes: 1) Searchable Database of Collaborative Programs, 2) Research Catalog (The Science Locator http://jester.wr.usgs.gov/scilocator_ims/viewer.htm), 3) Metadata Server, 4) Great Basin Bibliography, 5) Upcoming Meetings and Links, 6) List Server, and 7) an Experts/Participants Database.

GBRMP has supported several regional collaborative efforts, and the development of working groups to address invasive species, global climate change, science delivery, and monitoring issues.

0031

Breeding Strategies for the Development of Native Grasses

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Vast areas of semiarid rangelands in western USA are severely degraded and infested with troublesome weeds such as cheatgrass (*Bromus tectorum* L.) and medusahead rye (*Taeniatherum asperum* (Sim.) Nevski). Re-seeding with appropriate plant materials that are adapted to the site and competitive enough to replace existing undesirable vegetation is often the most plausible way to reclaim such sites. Most native grasses did not evolve under intense management or in association with species as competitive as cheatgrass. Genetically improved germplasms and cultivars of native grasses are being developed by the Forage and Range Research Laboratory (FRRL) of the United States Department of Agriculture - Agricultural Research Service (USDA-ARS). These plant materials have demonstrated the potential for increasing the genetic diversity, protecting watersheds and soil resources, and improving the habitat and grazing potential for livestock and wildlife on semiarid rangelands. This presentation will discuss the different strategies associated with native grass improvement. The proper choice of plant materials must be based on objective criteria if we are to protect our lands and natural resources from further degradation.

0032

History of Crested Wheatgrass (*Agropyron*) in North America

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Crested wheatgrass is indigenous to the Steppe region of European Russia and southwestern Siberia. It was first introduced into North America in 1892 by N. E. Hansen of the South Dakota Experiment Station. Dr. Hansen obtained five accessions, designated PIs 835, 837, 838, 1010, and 1012, from Valuiki Experiment Station near what is now Volgograd, Russia. Although original seed of these introductions were distributed to agricultural experiment stations, no permanent plantings or seed increases were made. A second importation, consisting of five seedlots (PIs 19537 through 19541) labeled as *Agropyron desertorum* and one seedlot (PI-19536) labeled as *Agropyron cristatum*, was received by N. E. Hansen in 1906 from the Valuiki Experiment Station. This seed was distributed to 15 experiment stations. Research initiated with these accessions in 1915 by the USDA-ARS at Mandan, North Dakota led to the initial acceptance of crested wheatgrass in the northern Great Plains. The first introduction of the Siberian form of crested wheatgrass (*Agropyron fragile*) was received from Russia in 1910 as PI-28307. The contribution of crested wheatgrass was particularly notable during the early settlement of the northern Great Plains of the United States and Prairie Provinces of Canada and is credited with salvaging vast areas of deteriorated rangelands and abandoned cropland during the depression and "dustbowl" period of the 1930s. Crested wheatgrass rapidly spread from the Great Plains to other semiarid regions and has become one of the most important range grasses in North America where it is an effective biological suppressor of cheatgrass (*Bromus tectorum*).

0033

Restoring Native Plants to Crested Wheatgrass Stands

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Crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.) is often criticized for forming nearly monotypic stands. Our objective was to determine the feasibility of restoring native plant species to crested wheatgrass-dominated rangeland. We investigated methods for suppressing crested wheatgrass followed by revegetation with a mix of native species. We tested five suppression treatments: undisturbed, low rate of glyphosate (0.25X recommended rate), high rate of glyphosate (recommended rate), 1-pass mechanical (disked once), and 2-pass mechanical (disked twice). Procedures were repeated in two trials in separate years in southeastern Oregon. We sampled density and canopy cover of crested wheatgrass and density of seeded species for three (Trial 1) and two (Trial 2) years. Mechanical treatments increased crested wheatgrass density by 30 to 50%, while most other treatments were similar to the undisturbed (6.8 plants/m²). Crested wheatgrass cover decreased in mechanical and full herbicide treatments in Trial 1 and was variable across treatments in Trial 2. Seeded species density in all treatments (29 plants/m²) was greater than in the undisturbed treatment (18 plants/m²) one year after seeding in Trial 1 and was similar across treatments (26 plants/m²) in Trial 2. By the end of the study, though, all treatments resulted in similar seeded species density (<5 plants/m²). Results suggest suppression treatments were not effective and therefore did not improve restoration of native species in crested wheatgrass stands. Native species establishment may require subsequent management to favor persistence of native species and retard crested wheatgrass.

0034

Crested Wheatgrass Control and Native Plant Establishment in Utah

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This research was designed to determine effective ways to reduce crested wheatgrass and establish native species while minimizing weed invasion. We mechanically (single- or double-pass disking) and chemically (1.1 L/ha or 3.2 L/ha glyphosate-Roundup Original Max) treated two crested wheatgrass sites in northern Utah followed by seeding native species in 2005 and 2006. Following wheatgrass-reduction treatments, plots were divided into 0.2-ha subplots that were either unseeded or seeded with native plant species using a Truax Rough Rider rangeland drill. Double-pass disking controlled wheatgrass the best initially, decreasing cover from 14% to 6% at Lookout Pass and from 14% to 4% at Skull Valley. However, crested wheatgrass recovered to similar cover percentages as untreated plots 2-3 yr after wheatgrass-reduction treatments. At the Skull Valley site, cheatgrass cover decreased by 14% on herbicide-treated plots compared to an increase of 33% on mechanical-treated plots. Cheatgrass cover was also similar on undisturbed and treated plots 2-3 yr after wheatgrass-reduction treatments, indicating that wheatgrass recovery minimized any increases in weed dominance as a result of disturbance. Native grasses had high emergence after seeding, but lack of survival was associated with short periods of soil moisture availability in spring 2007. Effective wheatgrass control may require secondary treatments to reduce the seed bank and open stands to dominance by seeded native species. Manipulation of crested wheatgrass stands to restore native species carries the risk of weed invasion if secondary treatments effectively control the wheatgrass and native species have limited survival due to drought.

0035

Sagebrush (*Artemisia tridentata* ssp *Wyomingensis*) Regeneration 23 Years Following Removal in South Central Wyoming

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Sagebrush removal for the purpose of increasing forage production for grazing animals or rejuvenating stands for wildlife has been a common rangeland management practice. The longevity of the sagebrush removal practice has an important bearing on the economics of the practice for forage production and efficacy for improving wildlife values. Sagebrush was removed using a 2,4-D (2,4-Dichlorophenoxyacetic acid) ground application at two pounds active ingredient per acre on one each of paired plots (plots were about 33 m by 33m) at 20 locations distributed over a range of sagebrush abundances from four percent ground cover to 40 percent cover in 1987. The ecological site was sandy in a 25-35cm precipitation zone. These plots were re-examined in May 2010 to determine sagebrush ground cover that had developed since treatment. Ground cover of sagebrush initially, and subsequent to treatment, was recorded at 100 points each on two 33m transects. With one treatment exception, sagebrush did not regain its pre-treatment abundance. Where pre-treatment abundances were 28 percent cover or below, recovery of sagebrush was 11 percent cover or less. Where pre-treatment sagebrush abundance was 32-40 percent cover, recovery varied from 14-34 percent cover. Untreated plots paired with the treated plots had changes varying from five percent increase to two percent decrease, with an average two percent increase. Increases were greatest where winter drifting snow catch was greater and/or pre-treatment understory vegetation was not perennial bunch grasses. For rejuvenating wildlife habitat values, the recovery time following sagebrush removal may be longer than desired.

0036

SRR Ecological Assessment Indicators: Selection and Monitoring Techniques

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The techniques that a producer or land manager would select for monitoring of ecological resources will vary with kind and characteristics of ecological sites being monitored, kind of land uses or sources of potential impacts, level of concern about various resource condition attributes, skills and interests of the manager, legal requirements and other variables. Characteristics of soil, water, plants and animals comprise the ecological indicators of ranch management function. Soil indicators include bare ground and soil aggregate stability. Water is assessed by examining timing and amount of water available including surface and ground water sources. Plant indicators are key species composition, extent of invasive species, extent of wildfire and prescribed fire, and extent and condition of riparian zones. Animal populations are primarily assessed through population size estimates although management system and productive capacity feed into economic assessments. A basic measurement tool for soil and plants is the line point transect. This technique measures soil and plant cover, thus bare ground and species composition are outcomes. Aggregate stability is a measure of the ability of soil surface peds to retain their shape when exposed to water. Water is monitored with precipitation gauges or NOAA sources, flow measurements, amounts, and presence /absence at important times or locations. Mapping and GIS techniques are useful ways of recording presence and change in invasive plants and fire area and locations. Greenline techniques for riparian zones. Animal populations are determined from species specific censusing techniques that may be used by various agencies or consultants.

0037

The Power of Personal Stories to Educate

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Agricultural viability, sustainable resource stewardship and preserving healthy rural Western communities seems as American as apple pie. Yet there is a huge disconnect between the general public and many of the policies and procedures we enact, and the men, women and children living in small rural communities trying to make a living in the field of agriculture who are caring for the natural resources that sustain our working landscapes. In an attempt to Amplify Rural Voices, Cooperative Extension in northeastern California and UC Davis Art of Regional Change led a multi-media storytelling project called **Passion for The Land** involving rural residents, artists and scholars to help residents engage with policymakers, local leaders, educators and the public. Project participants (ages 26-84) chose their topic, wrote and recorded their scripts and scanned family photos to help tell their stories. Local musicians supplied music and Cooperative Extension/University staff co-created twelve digital stories each 2-4 minutes long. The hope is these stories will trigger conversations among diverse audiences about important topics that are relevant across the nation. In less than a year, stories have reached over 5,000 viewers through social media outlets, an estimated 60,000 viewers via community television and roughly 1000 people at public presentations. Educators, state agencies, business organizations and NGO's are distributing the DVDs (700+) to targeted groups across the country. The Association of Natural Resource Extension Professionals gave it the Gold Award for Mixed Media in 2010. Stories are online: <http://artofregionalchange.ucdavis.edu>

0038

Rangelands in Large-Scale: History and Future

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Large-scale remote sensing images have been promoted for rangeland inventory, monitoring and management. Results have seemed promising but development has been slow. Originally data extraction of such images was primarily based on time-tested air photo interpretation protocols. Now it appears that the technology base for imaging systems and platforms has been successfully developed along with appropriate software. Images have been obtained with tripods near the ground, from fixed wing aircraft including ultralights, from helicopters and from balloons. High quality images are now the rule because of improved cameras and lenses. Image capture and storage is now routine and make such data readily available; although, there is a constant need to continually upgrade and improve software capabilities. Now, there is need to develop useful sampling protocols. Rangelands are diverse as we all know and while there are large homogenous areas it is clear that in mountainous terrain there are numerous ecosystems. Each slope (steepness), direction of slope and elevation presents to the sampler a unique rangeland ecosystem. How do we successfully sample this extremely heterogeneous landscape in a scientifically meaningful way? We must learn to economically subsample these landscapes and then extrapolate the information to larger areas on small-scale imagery. Also, how will the large-scale image data be used to assist in the making of important resource decisions? These are important issues for the future.

0039

Modifying the USDA-NRCS Pasture Condition Score System to Include Weighted Indicators

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The Pasture Condition Score (PCS) system, developed by the USDA-NRCS, is a monitoring and assessment tool for pastureland enrolled in conservation programs. Ten indicators of vegetation and soils status are rated on a 1 to 5 scale and summed to give an aggregate score, which is interpreted for management recommendations. The PCS system is used in rating pastures for NRCS cost-share programs. The original version of the PCS system has been modified in several states to address specific variations in vegetation and soils. One common modification of the original PCS system has been to assign weights to the individual indicators to emphasize or de-emphasize particular attributes in specific regions of the U.S. I used an existing data set on pasture condition scores to compare the effects of different weighting systems on the aggregate scores and their distributions. Five regional weighting systems (California central valley, irrigated areas and Southeast U.S., Northwest U.S., Midwest U.S., and Northeast U.S.) were used to compute aggregate pasture condition scores from a data set of > 1200 observations of pasture condition indicators measured on five farms. Distributions of pasture condition scores from the five systems were compared with those obtained from using the original system. Except for a few instances, the various weighting methods did not change aggregate PCS scores compared with nonweighted scores. In all modifications of the original PCS system, plant vigor was the most heavily weighted indicator; whereas, plant residue was the least weighted. The indicator weights used in regional modifications of the PCS system do not appear useful.

0040

Is Rehabilitation of Non-Forestlands after Wildfires Effective? - A Systematic Literature Review

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Substantial money is expended annually on post-wildfire rehabilitation and stabilization of non-forested lands. Major objectives are to prevent soil erosion and to curtail spread of invasive plants; however, little is known about effectiveness of these treatments. The most common approaches include seeding shrubs and herbaceous species via either aerial broadcasting or ground-based drills. We compiled literature ranging from peer-reviewed journal articles to end-of-project monitoring reports to answer two sets of questions: 1) do seeding projects effectively control soil erosion or spread of invasive plants, and 2) do environmental, geographic, and implementation factors change the effectiveness of the treatment? Peer-reviewed literature was limited on these topics and provided mixed results. We further investigated 223 BLM end-of-project reports that included 370 treatments applied after fires that occurred between 2001 and 2006. Aerial seedings (214) were nearly double drill seedings (114). Most treatments used seed mixtures composed of 100% native species. Preliminary data indicate that 32.9% failed, 26.0% had poor success, and 20.6% had fair or better success. These reports and their monitoring did not directly test the objectives but focused on seeded plant establishment. For treatments where geographic data were available, logistic regression was performed where success (failure/poor vs. fair/good) was compared as a binary output. Low precipitation negatively affected aerial seedings but was neutral for drill seedings. In general, locations with higher elevation had greater success, likely due, in part, to greater precipitation.

0041

Forage Quality Dynamics of Warm Season Grasses During the Growing Season in West-Central Texas

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Nutritive quality of grass is important to livestock producers as they make pasture and grazing management decisions based on the nutritional needs of the grazing animal. Understanding the nutritive quality of warm season grasses throughout the growing season is needed in west-central Texas to assist livestock producers with forage management options. Our study objective is to compare nutritive distribution of five perennial grasses native to the southern plains and one introduction from southern Africa to determine optimum forage harvest times to meet nutritional requirements of different classes of beef cattle. Plots of 'Alamo' switchgrass (*Panicum virgatum* L.), 'San Marcos' eastern gamagrass [*Tripsacum dactyloides* (L.) L.], 'Earl' big bluestem (*Andropogon gerardii* Vitman), 'Lometa' Indiangrass [*Sorghastrum nutans* (L.) Nash], 'Selection 75' kleingrass (*Panicum coloratum* L.), 'Haskell' sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.] and an upland switchgrass (9065018) were evaluated every 30 days for percent in vitro dry matter digestibility (IVDMD) and crude protein (CP) from April through November in 2007-2009 at the USDA-NRCS James E. "Bud" Smith Plant Materials Center, Knox City, Texas. Our results suggest these warm season grasses decline in nutritive quality as season and maturity progress, but can provide the nutritive requirements of different classes of beef cattle in west-central Texas. Switchgrasses, unlike most entries, declined in nutritive value more than others. Selection 75 and San Marcos CP (8 and 9%, respectively) remained above critical ruminant requirement thresholds even into November, indicating promise as standing winter hay.

0042

Examining Disturbance and Environmental Mechanisms Regulating Plant Species Dynamics in Native *Festuca campestris* Grassland

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Foothills rough fescue (*Festuca campestris*) grasslands are valued for their biodiversity and contribution to livestock grazing in western Canada. Fescue grasslands are complex communities that are increasingly under threat of invasion by non-native species. We conducted an in-situ field study in a native rough fescue community within the foothills of western Alberta, Canada, from 2005 through 2008, in order to assess the role of disturbance and environment in regulating plant species dynamics. A total of 16 manipulative treatments were used in an incomplete factorial design (8 replications) including: annual nitrogen addition (100 kg/ha for the first year and 20 kg/ha thereafter), annual water addition (every 2 weeks to field capacity), one-time summer (July 2006) defoliation, one-time winter (Nov 2005) defoliation, and litter removal (Nov 2005). All plots were monitored from 2006-2008 for both plant community (species richness, diversity and individual species composition) and environmental measures (monthly light, bimonthly soil, annual soil nitrogen assessment). Community responses were assessed using ordination and MRPP to assess the specific role of defoliation and environment. Results indicated that changes in plant community composition, including Kentucky bluegrass (*Poa pratensis*) abundance, were primarily associated with the disturbance of summer defoliation and nitrogen addition. In contrast, rough fescue was associated with soil moisture and initial litter abundance. These results have implications for the conservation and management of rough fescue grasslands.

0043

Differential Responses of *Poa pratensis* and *Festuca campestris* to Defoliation and Microenvironment

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Foothills rough fescue (*Festuca campestris*) is the climax species of fescue grasslands in southwestern Alberta where it provides critical winter grazing for agriculture and habitat for wildlife. Fescue grasslands have been increasingly under threat of invasion of non-native plants such as Kentucky bluegrass (*Poa pratensis*); thereby, greatly complicating their retention and conservation. Long-term data sets from this region suggest bluegrass invasion may be tied to both disturbance history (grazing) as well as variation in growing conditions (particularly moisture). As a result, we conducted a manipulative field study to assess the effect of summer and winter defoliation, litter removal, and nitrogen or water addition on the growth response of both foothills rough fescue and Kentucky bluegrass. Plots were established in 2005 using an incomplete factorial design with 16 treatment combinations in 8 replicates and assessed over 3 subsequent growing seasons. Changes in the cover, tiller density and biomass of each species were measured, together with environmental conditions (light availability, soil moisture and soil N availability). Results suggest that rough fescue and Kentucky bluegrass demonstrate contrasting responses to water and nitrogen availability, as well as seasonal defoliation. Thus, differences in species response to disturbance and environment help explain the abundance of these species within fescue grasslands.

0044

Mechanisms Responsible for Enhancing the Restoration of *Festuca campestris* into a *Phleum pratense* Dominated Plant Community on a Pipeline RoW

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The fescue grasslands of the southern foothills are diverse, ecologically sensitive areas important for agriculture, recreation, wildlife and industry. Recent pressures from industry, urban expansion and recreation have increasingly exacerbated the effects of agriculture, culminating in destabilization of many plant communities. Timothy (*Phleum pratense*) invasion has become a widespread problem in these grasslands with or without industrial activity, but on industrial sites establishment of foothills rough fescue (*Festuca campestris*) has been plagued with failures. In 2008, 10 sites were selected along a reclaimed pipeline that had high timothy cover and presite assessments were conducted. In the spring of 2009, 1000 greenhouse grown rough fescue plugs were planted at 1 plug/m² at each site. Monitoring of 600 of these plants occurred under 6 randomly selected sets of plugs (10 plugs) across each site. In spring 2010, 600 more plugs were planted on the opposite side of each marker. Annual timothy control was initiated in 2009 through wick application (glyphosate), mowing and a combination of the 2 techniques on 5 sites, with 2 sets of fescue in each treatment. Another 5 organic sites received mowing treatments (presence/absence) with the fescue divided between the treatments. Survival of rough fescue was compared to cover, biomass species composition and historical grazing patterns. Results suggest rough fescue survival was highly correlated with bare ground and low vegetation biomass associated with the pretreatment conditions and grazing patterns. Mortality of fescue appeared to be associated with competition (plant biomass) and herbivory by mice.

0045

Relationships of Fire to North American Grouse

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Grouse have often been characterized as umbrella species under which the biodiversity of an entire ecosystem can be managed for. Many grouse species are in serious long-term declines which have raised concerns about landscape management (or lack thereof) and how it might impact these species. Further, fire is a critical process to maintain ecosystem function and biodiversity of all rangelands. While scale, both temporal and spatial, varies between ecosystems in which grouse occur, the process of fire is one of the most important drivers of the plant community, second only to climate and soil. The disruption of historic fire return intervals represents one of the greatest threats to grouse persistence. In most cases, this is due to decreases of historic fire, and in a few cases due to increased fire frequency from historic intervals. The challenge for range and wildlife professionals is to identify the appropriate scale of disturbance that will maintain ecosystem function and biodiversity (including grouse) and then overcome social barriers to its application. We will examine several grouse species as case studies including: ruffed grouse (*Bonasa umbellus*), greater prairie-chicken (*Tympanuchus cupido*), lesser prairie-chicken (*Tympanuchus pallidicinctus*), and greater sage-grouse (*Centrocercus urophasianus*).

0046

Pasture and Grazing Management in the Northwest: A New Guidebook

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A multi-state program of research, education, and extension for pasture-based livestock production systems was identified as a priority at a Pacific Northwest Forage Workers Conference in 2003. A grant proposal for professional development to the Western Sustainable Agricultural Research and Extension (WSARE EW05-012) was awarded in 2005. The project was designed with three phases: 1) professional development education and training; 2) research to determine the relationship of sward height and herbage mass for forage in rotational pasture systems in the Northwest; and 3) publish a comprehensive management guide. Pasture and Grazing Management in the Northwest is a Pacific Northwest Extension Publication PNW 614. There are 17 chapters and a glossary by 36 authors from Cooperative Extension, USDA Agricultural Research Service and Natural Resources Conservation Service, a livestock producer, and a private consultant. Authors are located in the states of Washington, Oregon, Idaho, Montana, Utah, and West Virginia. The 208 page document edited by Glenn Shewmaker and Mylen Bohle is published by the University of Idaho Extension. This is the first comprehensive management guide for pastures and grazing in the Northwest.

0047

A Quantitative Protocol to Assess the Invasive Potential of a Plant Species into a Rangeland Ecosystem Using *Camelina sativa* (Gold of Pleasure, Large-seeded False Flax) as a Model

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We present a quantitative approach to assessing the invasive potential of a proposed plant biofuel species, *Camelina sativa*, into rangeland ecosystems. We collected demographic data over two years to assess the probability of *C. sativa* to invade rangeland ecosystems of south-central Montana, USA. Specifically, the objectives of this study were to 1) incorporate demographic data on *C. sativa* in response to different environments into a population dynamics model, thereby offering a quantitative prediction of invasion potential, and 2) compare these results to predictions suggested by the widely used, qualitative Australian Weed Risk Assessment (WRA) system. *C. sativa* was found to pose a low threat of invasion in the assessed habitats, as positive population growth ($\lambda > 1$) was not obtained using observed data. Thresholds to create growing populations could only be achieved by combining large increases in seed survival with large annual inputs of new seed. In contrast to our experimental results, the WRA suggested that *C. sativa* should not be allowed entry into the region, thus highlighting the need for a more comprehensive approach to assessing invasion potential of proposed biofuel species.

0048

Ecosystem Services: The New Motive for Range Improvements

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Economic assessments of range improvement projects have traditionally evaluated and valued the added livestock forage and pounds of beef that the improvement practice is expected to generate. Yet, only on the most productive rangelands is enough production added to economically justify the total expense for many such projects. With the 2003 implementation of the Conservation Effects Assessment Project (CEAP), headed by the Natural Resource Conservation Service (NRCS), there is a renewed recognition that range improvements and conservation practices funded with cost share monies can provide goods and services that society values beyond the livestock products traditionally considered. Improving rangeland health, improving watersheds, improving habitats for wildlife, releasing water for other uses, and enhancing numerous other non-quantified ecosystem services has been the justification for many cost share projects. We explore how economic assessments of improvement practices will need to change if an economic value is to be placed on the ecosystem services provided by rangeland improvements. We review the non-market valuation procedures that could be used to place an economic value on these services while concluding that little potential exists for showing substantial economic value for some of the ecosystem services commonly touted, including watershed benefits on arid upland rangeland areas. In other cases, like carbon sequestration, substantial research and development of economic markets and incentives must occur.

0049

I. Trophic Cascades Involving Large Predators, Wild Ungulates, and Plants in the Western US: Do Large Predators Have a Role?

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Large predators may help shape the structure and functioning of terrestrial ecosystems via trophic cascades, yet strong evidence of these "top-down" effects have not been widely reported in the scientific literature. Herein we synthesize outcomes of recent studies assessing the presence and absence of large predators for five national parks in the western United States, including Olympic, Yosemite, Yellowstone, Zion, and Wind Cave. Following the extirpation or local displacement of large predators, recently compiled age structure data for deciduous trees indicate severe declines in shrub communities and deciduous tree recruitment (i.e., the capability of seedlings/sprouts to grow above the browse level of native ungulates) occurred. These impacts indexed additional effects to plant communities and ecological processes, and shifts towards alternative ecosystem states. In contrast, wolf reintroduction in Yellowstone appears to have begun to reverse many former ecosystem impacts formerly associated with intensive elk herbivory.

0050

II. Impacts to Riparian Biodiversity and Channel Morphology Following Large Predator Loss in Several Ecosystems of the Western US

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In several recent trophic cascades studies in the western United States, the loss of an apex predator allowed wild ungulates to heavily impact riparian plant communities. Herein we summarize the accompanying biodiversity changes to native plants and animals that appear to have occurred as riparian plant communities became degraded. We also consider the general effects upon stream channels (e.g., streambank erosion, channel widening and incision, loss of pools) associated with these herbivore-impacted systems. Where ungulates have significantly altered riparian plant communities in the absence of large predators, restoring native flora is urgently needed to recover former ecosystem functions and services.

0051

Effects of Fuel Load, Heterogeneity, and Environmental Conditions on Fire Behavior in Grasslands - Results from a Physics Based Process Model

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

0052

Effects of Fire and Herbivory on Sentinel Species across the Landscape of Northeastern Montana

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The use of traditional community composition methods to monitor ecosystem drivers on complex landscapes is inefficient. Community composition alone does not provide diagnostic capabilities and should be coupled with additional monitoring methods. Sentinel species may be used to determine impending changes in a community due to altered ecosystem drivers. A trend of declining abundance of palatable, fire tolerant species on the diverse landscape of the Charles M. Russell National Wildlife Refuge, Montana provides an opportunity to test the usefulness of sentinel species as indicators. Traditional point-intercept transects were compared with newly developed sentinel transects that collect descriptive species information. Permanent exclosures were erected and caged and uncaged plants measured for reproductive capacity, herbivory, and growth. The transect methods each provided generally unrelated information and neither were fully capable of evaluating rare sentinels. The sentinel transect method found no difference in dominant sentinels including Wyoming big sagebrush between burned and unburned treatments for presence in 1 (33.7 ± 5.3 and 40.0 ± 8.4) and 10 m² (73.3 ± 7.2 and 83.3 ± 10.3) plots. Improvement of rare sentinels was measured only when they were protected from herbivory and caged plants were healthier than uncaged plants for all variables measured (P < 0.05). Overutilization of site subordinate sentinels appears to be the main management concern for these species on the CMR compounded by effects from an altered fire regime. Sentinel species should be evaluated for use as indicators on all landscapes for the management of ecosystem drivers.

0053

Assessing Riparian and Aquatic Habitat Using Very-High Resolution Imagery

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Monitoring is a part of sustainable resource management and is mandated by US federal law for federal land-management agencies. Riparian- and aquatic-habitat monitoring methods are labor-intensive such that sample intensity and distribution are limited by labor availability and cost. These limitations reduce the effectiveness of landscape-level resource management. To test the utility of very-high resolution (VHR) aerial surveys for these assessments, we acquired imagery (2- to 36-mm ground sample distance) for perennial streams in the 330,000-ha Rock Creek watershed, Elko County, Nevada, and for three 3.2-km stretches of the Powder River, Johnson County, Wyoming. The questions were: 1) is a reduction in hot-season grazing allowing an increase in willow (Rock Creek), and 2) is coalbed methane well effluent changing the in-stream habitat conditions of the Powder River? To assess the effectiveness of reduced hot-season grazing we conducted aerial surveys in 2003, 2004 and 2006. Measurements made from the images revealed a 3.1% increase in willow cover along channels, and a 55% increase in willow canopy diameter between 2003 and 2006. We monitored the Powder River with 6 flights--each carrying multiple cameras--between 2007-2009, and from that imagery measured the area of 10 types of aquatic habitat and the occurrence / non-occurrence of salt cedar (*Tamarix* L.) within the channel. We found no evidence of a methane-well effluent effect on the measured indicators. The aerial surveys of both projects produced testable data with greater sample density and distribution, and at lower costs, than could be obtained by conventional ground methods.

0054

Evaluation of Sand Sagebrush Control in a Southern Mixed Prairie: Implications for Lesser Prairie Chicken Habitat Management

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Traditional management of rangelands dominated by sand sagebrush (*Artemisia filifolia*) has centered around removal of sagebrush to increase forage for livestock production. There has been both concern and support over shrub control strategies when managing lesser prairie-chicken (LPC, *Tympanuchus pallidicinctus*) habitat. The objective of this research was to determine what impacts chemical control of sand sagebrush may have on LPC habitat values. The study was conducted in a southern mixed prairie sand sagebrush community in western Oklahoma, pastures ranged in size from 10 to 21 ha. Five pastures were sprayed with 2,4 dichlorophenoxyacetic acid (2,4-D) in 2003 (RECENT), 6 were sprayed with 2,4-D before 1994 (INTERMEDIATE), and 4 received no brush control (CONTROL). Sagebrush cover, visual obstruction (VO), forb density, basal grass cover and grass hopper density were measured on all pastures. Sagebrush cover and VO estimates were greatest in CONTROL pastures and lowest in RECENT pastures. Perennial Forbs important to LPC were most abundant in CONTROL pastures and least abundant in RECENT pastures. Annual forbs important to LPC were most abundant in INTERMEDIATE pastures; there were no differences between CONTROL and RECENT pastures. Grass hopper densities did not differ among the 3 treatments. CONTROL pastures provided the most abundant escape cover while providing food for LPC. These results suggest that 2,4-D reduces escape cover and perennial forbs important to LPC. Thus, use of 2,4-D is not be appropriate for improving LPC habitat because it reduced escape cover and important food sources.

0055

The Constant Gardener: Ecosystem Effects of Seed Dispersal by Ungulates

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Dispersal of seeds by ungulates, whether internally through ingestion and excretion (endozoochory) or externally through seed attachment on animals (epizoochory), can be a major driver in establishing new populations of plants and altering composition of existing vegetation communities. Although all orders of terrestrial ungulates affect ecosystems through this mechanism, the primary ungulate species for which zoochory has been reported are Artiodactyls. Zoochory has shaped plant communities, from rangelands to forests for millennia. However, more recent introductions of non-native invasive plant species around the world, and the facilitated spread of these taxa through seed dispersal by ungulates, may pose substantial threats to native plant communities. Effects of zoochory on plant communities vary widely due to a host of factors, including: 1) the ungulate species involved, 2) its abundance, size, density, digestive physiology (e.g., ruminant or monogastric), and home range area, 3) interactions of plant phenology and season of grazing by the herbivore, 4) susceptibility of the plant community to colonization by the transported seeds, and 5) the scale at which effects are considered. Given the difficulty in field studies to quantify seed dispersal by ungulates and subsequent effects on plant establishment, the role of this mechanism in altering vegetation communities is likely underestimated. We review mechanisms by which ungulates facilitate dispersal of seeds, highlight the most common ungulate taxa involved in zoochory, and present several case examples that typify effects of seed dispersal by ungulates on vegetation composition and structure.

0057

Seedlings: From Seed to Establishment

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The necessity of resource managers to restore or rehabilitate rangelands throughout the Intermountain West is at an all-time high. With each passing year more and more hectares are being converted from plant communities dominated by native vegetation to plant communities dominated by the exotic and highly invasive species cheatgrass (*Bromus tectorum*). The objective of this paper is to describe on-the-ground lessons learned. Seedling emergence, mortality and establishment will be discussed in detail. We will present data on the importance of proper timing of seed sowing and proper use of plant materials as it relates to success of seeded species and cheatgrass suppression. Seed predation is a reality; we will present data on seed and seedling predation and how this activity can significantly affect restoration efforts. We will present data on our techniques of seeding plots and observing these plots from the time of seeding through five years after the seeding. For example, we seed in the months of September and October, then observe these quadrats for seed predation, snow cover, germination, emergence, seedling predation, mortality, and recruitment into the environment. We also monitor the periodicity of precipitation as it relates to seedling survival. The majority of the environments we work in receive less than 23 cm (9 inches) of annual precipitation, mostly occurring in winter months; we will discuss our experiences of success and failures as it relates to on-the-ground realities that occur throughout the various plant communities.

0058

Extension Outreach in Tropical Range and Livestock Management for Pacific Islanders

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High demand for product and limited land availability impose tremendous pressure on livestock producers to maximize their productivity; often at the expense of the land resources. Improper grazing management practices typically result in decreased forage production, animal carrying capacity, and soil fertility and quality. Without mitigation these conditions lead to overgrazing resulting in soil erosion, weed infestations and loss of economic viability of the operation. Outreach and assistance in grazing and livestock management can help existing and new livestock producers acquire the necessary skills and technology for pasture improvement, adopt better grazing management practices, and increase the profitability of their operations. Partnering with the University of Virgin Islands, University of Guam and Northern Marianas College, the University of Hawaii Cooperative Extension Service secured funding to organize an extension outreach project in tropical range and livestock management for Pacific Islanders. In the initial phase needs-assessments were carried out utilizing rancher interviews, ranch resource evaluations, and producer advisory groups formed to help guide the compilation and dissemination of locally important, relevant, and useful information in range and livestock management. The program has encouraged adoption of sustainable range and herd management practices, improvement of herd genetics, and better marketing decisions. In addition to the contacts and ranch evaluations, this project has resulted in a series of workshops, producer resource books, a pocket-record book specific to the islands, a project website, and establishment of several demonstration trials across the islands. The success of the program has lead to additional funding to continue the effort.

0059

Conquering Social and Ecological Fire Thresholds to Empower and Equip Ranchers to Manage Rangelands

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The emergence of social and ecological thresholds has completely altered the application of fire in rangelands. Historically, few thresholds constrained fire on the landscape. Natural and anthropogenic fires were largely unrestricted and predominately shaped the distribution and abundance of vegetation, herbivores, and wildlife. This all changed at the turn of the 19th century. Early European settlers transformed the ecological processes governing the landscape by introducing stock-farming, domestic livestock, and fire suppression. These practices eventually led to widespread overutilization and degradation of rangelands, leading to catastrophic losses of the herbaceous plants needed to sustain fire, and enabling uninhibited woody plant encroachment. As a result, the production and diversity needed to maintain rangeland enterprises was lost as grasslands and savannas were converted to high density woodland communities. In the 21st century, rangeland managers face a complex array of social and ecological thresholds that dictate rangeland management techniques. Those individuals looking to use prescribed fire face a number of social barriers associated with legislation, economics, experience, education, labor or assistance, liability, and negative public perception. Furthermore, traditional applications of prescribed fire in mild, "safe" conditions have been unable to overcome the resilience of post-grassland woodland communities, causing many to suggest prescribed fire is an inefficient management strategy in these environments. Here, we discuss a social-ecological framework involving the use of prescribed extreme fire and prescribed burn cooperatives that enables ranchers and resource managers to overcome the social and ecological thresholds constraining fire, leading to more effective and profitable rangeland management.

0060

Managing Rangelands for Multiple Ecosystem Services: Beyond Bement (1969)

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Many rangelands have traditionally been managed to optimize livestock production through the use of sustainable stocking rates. One of the seminal research papers on this subject was published by Robert (Bob) Bement in the *Journal of Range Management* in 1969 (volume 22, pages 83-86). This paper, entitled "A stocking-rate guide for beef production on blue-grama range" demonstrated the relationship of livestock daily gains per head and gains per unit land area to stocking rate in shortgrass steppe of Colorado, USA. High daily gains per head and low gains per unit land area occurred with low stocking rates; conversely, low daily gains per head and high gains per unit land area occurred with high stocking rates. Optimum livestock production was observed at the intersection of these two response curves, at a moderate stocking rate. Findings from this paper had a profound impact on the sustainable management of rangelands for livestock production across North America. Contemporary management of these rangelands, however, emphasizes enhancing multiple ecosystem services from these lands. Tradeoffs associated with changing management from traditional approaches emphasizing livestock production to managing for multiple ecosystem services remain a research and information gap. For example, what are the ramifications to livestock producers in terms of animal gains associated with changing management to emphasize multiple ecosystem services? If management for multiple ecosystem services results in lowered animal gains, what is the value of this loss of gain that can be compensated to land managers in terms of incentives to modify management?

0061

Assessing the Success of the UtahPCD Watershed Restoration Initiative

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Over the last six years, the Utah Bureau of Land Management in cooperation with the Utah Partners for Conservation and Development (UtahPCD) has conducted vegetative manipulations statewide within high priority focus areas under our program entitled: The Watershed Restoration Initiative (WRI). The objectives of the treatments are three fold: 1) maximize natural biological diversity, 2) maintain and/or improve water quality and quantity, and 3) maintain and/or improve vegetative cover, vigor, and composition. Since the inception of the WRI, each restoration project has been designed and conducted under the guidance and input of biologists, ecologists, local experts and land managers to best accomplish the stated objectives. Now, six years out in some cases, participants in the WRI believe anecdotal information suggests that the treatments are improving watershed conditions. However, aside from a few site specific monitoring studies and long term statewide big game range vegetative trend plots, it is difficult to assess overall progress towards our stated objectives. As such, the BLM and our partners are working to gather more pertinent information necessary to quantify and qualify our success, and to provide a basis to adjust our vegetative manipulation methodologies if needed.

0062

89 Years of Photo Monitoring of Resources in the Gravelly Mountains of Southwest Montana

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While working as a Range Specialist on the Madison RD, I discovered many old photos as well as vegetative studies taken on the district concerning the range resource. To date I have located and rephotographed over 1200 photos since I started in 2003. The sites were located while doing administrative checks in the pastures. I have located panoramic photos and vegetative studies including: Vertical Photo Plots, Parker 3 Step Transects, Riparian Photo Plots, Stream Cross Sections and general photos of resources. This long term photo monitoring shows improvement in the rangeland resource, while showing change in the landscape. Parker 3 Step and Stream Cross Sections Transects were reread for additional data. The data shows little change, however the photos tell a different story. With declining budgets and manpower, Range Specialist need an easier, quicker way to do long term monitoring. While photos won't show species composition, they will show vegetative cover, litter and bare soil. Photos are repeatable, easy to take and anyone can understand them. Locations can be GPS'd for repeats. Computer programs are available to analyze vertical photos. Given time these programs may be able to discern species from photos. These photos show an improvement in the riparian and range, and an increase in conifer encroachment and loss of aspen.

0063

Development of a Habitat Appraisal Guide for Rio Grande Wild Turkeys in South Texas

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The Rio Grande Wild Turkey (*Meleagris gallopavo intermedia*) is a large gallinaceous bird native to Texas that requires a variety of habitats in order to maintain a stable population. The purpose of this study was to generate a habitat appraisal guide to evaluate RGWT habitat in the south Texas plains region. The guide will systematically evaluate current habitat conditions and determine limiting factors for RGWT. The information provided will enable biologists to work with landowners to determine if their land is suitable habitat for RGWT and consider management suggestions to enhance habitat. The study was conducted in Brooks and Kennedy counties on the Encino division of the King Ranch approximately 30 kilometers south of Falfurrias, Texas. The vegetation on the Encino division is described as a mixed brush community. Vegetative characteristics for roosting habitat, nesting habitat, brood habitat, and feeding habitat were evaluated in order to determine what parameters in each category are needed in order to sustain a stable population of wild turkeys. Sixty-three hens were trapped via standard walk in traps and fitted with backpack radio transmitters. During the spring hens were located daily in order to locate nest and brooding sites. Feeding sites were determined based on the visual recognition of birds feeding. Logistic regression was used to compare vegetative characteristics between initial sites and random sites. The results will be provided to the Texas Parks and Wildlife Department to help assess RGWT habitat in south Texas.

0064

Research to Practical Use: On-the-Ground Successes

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The U.S. Department of Agriculture, Agricultural Research Service, Exotic and Invasive Weeds Research Unit services a large area that runs from southern Nevada to the Oregon border, and from northeastern California to the Utah border. This vast array of landscapes has a variety of stakeholders who demand help concerning sustainable agricultural practices and concerns. This paper will present three examples of our efforts to: 1) research the problem on hand, 2) deliver practical on-the-ground practices to minimize or eliminate the problem, and 3) improve sustainable agricultural practices. The first example will be in the area of tall whitetop (*Lepidium latifolium*) control and rehabilitation. We will present information on controlling tall whitetop in a former agriculture field using a variety methods (herbicide, mechanical, biological) and then returning the site back to agriculture production. The second example will be on the suppression of cheatgrass (*Bromus tectorum*) in Wyoming big sagebrush (*Artemisia tridentata*) communities. We will present information on cheatgrass suppression immediately following wildfires, and years after the wildfire has occurred. The third example will be in the area of shrub restoration, specifically, antelope bitterbrush (*Purshia tridentata*). The restoration of this critical browse species was once forgotten due to building frustrations of resource managers and the inability to successfully seed this species. Again, we will present on-the-ground lessons learned, and successes on restoring this critical browse species on western rangelands.

0065

Cheatgrass Biomass and Competition: Is a Greenhouse Fight a Fair Fight?

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Revegetation of degraded rangelands is a tremendous challenge for land managers. Crested wheatgrass (*Agropyron cristatum*), a plant with the potential to compete with cheatgrass (*Bromus tectorum*), has been a valuable tool for land managers in decreasing fire frequency and promoting assisted succession towards native grass/shrub communities. Salt desert shrub habitats, often below the establishment potential of crested wheatgrass, are becoming increasingly threatened by cheatgrass invasion and fire. In response, we examined the potential for native annual forbs to suppress cheatgrass. Understanding an annual's limitations, we initially observed the interaction between the annual's presence and cheatgrass biomass, a fuel for fires. In a greenhouse study paired with field plots, we tested the effect of the presence of an annual on the biomass of cheatgrass. Our results found that the greenhouse study had more annual species significantly ($P \leq 0.05$) affecting cheatgrass biomass (10/11 species) than the field test (2/11 species) [e.g. Greenhouse: control = 5.12g *Amsinikia tessellata* present = 1.39g (80% reduction), Field test: control = 4.83g, *Amsinikia tessellata* = 0.62g, (87% reduction)]. Under greenhouse conditions moisture may not be the limiting factor and nutrients become limiting. This results in cheatgrass having less competitive advantage. However, in the field our results found that annual species rarely established with cheatgrass competition. It is unlikely that assisted succession can occur without the prolonged suppression of cheatgrass and the presence of the assisting plant. The confounding results of greenhouse and field tests emphasize the requirement for on the ground "proofing" of cheatgrass greenhouse competition research.

0066

Working with Private Landowners to Recover Sage-Grouse Habitat and Improve Ranching Sustainability

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Sage-grouse, an iconic west-wide symbol of healthy rangeland ecosystems, have experienced significant population declines. Approximately 30% of sage-grouse habitat occurs on privately-owned lands and this link makes the USDA- Natural Resources Conservation Service (NRCS) uniquely positioned to focus agency resources to benefit sage-grouse, improve ranch sustainability, and maintain livestock grazing as the prevailing land use. In 2010, USDA launched a new and exciting Sage-grouse Initiative (SGI) and provided \$21 million in cost-share assistance to sustain working ranches and conserve greater sage-grouse. NRCS Chief Dave White is using popular NRCS conservation programs including Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Incentive Program (WHIP) to assist producers in 11 western states (CA, CO, ID, MT, NV, ND, OR, SD, UT, WA, WY) to simultaneously improve habitat for sage-grouse and improve sustainability and productivity of native rangelands. This symposium contains presentations about the structure of SGI, new GIS-based decision support tools, salesmanship of conservation, state-specific examples of how this initiative is being implemented, ecological site descriptions, FWS conference report summary, and the current SGI assessment projects underway.

0067

NRCS - USFWS Conference Report

Terrell Erickson

NRCS, National Office, United States

The NRCS and USFWS have used the "conferencing" provisions under Section 7 of the Endangered Species Act to assess the potential benefits and adverse effects of specific NRCS conservation practices to be implemented and maintained by landowners under the Sage Grouse Initiative. The FWS worked closely with NRCS to determine the effects of 40 individual conservation practices, both those that will be beneficial and those that could potentially adversely affect the birds and their habitat. Conservation measures were developed to avoid, ameliorate or minimize the identified adverse effects that could result from implementation of the practices prescribed in landowners' conservation plans. The conference report lets landowners know that should the Gunnison or Greater sage-grouse species be listed at a future date, they can continue implementing any of the report's 40 NRCS conservation practices and associated conservation measures.

0068

The Ecological Reserve El Uno - Strategies for Integral Range Management in Short Grass Prairie in the Northwest Chihuahua, Mexico

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A range management strategy was developed for The Nature Conservancy Ecological Reserve "El Uno" located in the Janos Valley. In this approach we allowing for the interest of the stakeholders of the area. Thirty sampling sites were randomly distributed into the ecological reserve. For each site general landscape characteristics were recorded to identify threats and trends. Also, the actual condition was evaluated applying the Indicators of Range Health V.4 (BLM TR 1734-6). To asses' vegetation attributes (e.g. structure, composition, production, invasive species cover, wildlife habitat) the line point intercept, gap intercept, belt transect and cover pole methods were used as suggested by the USDA-ARS Jornada Experimental Range Monitoring Manual 2005. Results showed that on average, range health is moderate, finding sites under slight to moderate and extreme degradation condition. Threats are represented by mesquite and tumbleweed invasions, leading more than 50% of the reserve into desertification trend. Vegetation features indicate a range compounded by mainly four genius grasses (*Bouteloua*, *Aristida*, *Hilaria*, and *Sporobolus*) associated with patches of mesquite, tumbleweed, and catclaw; and areas of bare ground ranging from 25% to 80%. Recommendations include mesquite control, prescribed burning, low stocking rate in pastures with best health condition, and high stocking rate low frequency in pastures were the tumbleweed and mesquite are invading.

0069

NRCS Sage-Grouse Initiative: Montana Example

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NRCS consulted many stakeholders and developed the Greater Sage-grouse Habitat Conservation Strategy in 2008. The plan identifies 13 core areas that collectively reduce the 27 million acres of sage-grouse occupied area in Montana to 9 million acres that contain 75% of the sage-grouse. In 2010, core area 4 was prioritized and NRCS focused technical and financial resources to saturate this area with conservation practices alleviating all identified threats to sage-grouse. Core area 4 covers 185,982 acres in Golden Valley and Musselshell counties, of which 150,000 acres are privately owned rangeland. Detailed resource inventories were completed and all threats to sage-grouse and rangeland sustainability were identified. The findings of the inventories revealed high bare ground percentages, low plant residual cover, and generally reduced rangeland health. Many fences were located near sage-grouse lek sites and no watering tanks had wildlife escape ramps. These factors contribute to limitations in ranch productivity and pose serious threats to sage-grouse survival. NRCS developed comprehensive management plans with 9 ranches, totaling 90,000 acres. The resulting contracts remove all identified threats to sage-grouse and improve rangeland health and productivity on roughly 50 percent of the entire core area. In the summer of 2010, emphasis has been expanded to include Core areas 3 and 6 as well as additional interested landowners in Core 4.

0070

NRCS Sage-Grouse Initiative: Overview and Structure

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The NRCS Sage-grouse Initiative (SGI) capitalizes on the strong link between conditions required to support sustainable ranching operations and habitat characteristics that support healthy sage-grouse populations. NRCS structured SGI to be a collaborative, targeted effort to implement conservation practices with its conservation partners throughout the West. This initiative builds off state wildlife agency sage-grouse strategies by addressing known threats in each state and focusing resources on core areas important to sage-grouse. SGI includes science-based evaluations carried out by reputable, independent scientists to measure the biological response of sage-grouse populations to conservation practices, to assess SGI effectiveness, and to improve program delivery. Additional collaboration with the US Fish and Wildlife Service (FWS) ensures that listing decisions are well-informed and landowners are given certainty that they will be able to continue with practice implementation regardless of listing determinations.

0071

Plant Selection Strategies for Improved Plant Establishment in Saline Environments

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Over 243,000 hectares of south Texas land is affected by saline conditions. In order to solve erosion problems and increase the productivity on saline impacted range sites, it is critical to develop plant material that is adapted to these severe conditions. We will discuss the various plant selection strategies that we employ at the USDA-NRCS E."Kika" de la Garza Plant Materials Center in Kingsville, Texas to develop commercial releases for improved plant establishment in saline environments.

0072

National Estimates of Soil Loss on Rangelands

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Since 1995, an interagency group composed of the Natural Resources Conservation Service, Agricultural Research Service, and U.S. Geological Survey have worked together to develop a robust field approach for National Resource Inventory (NRI) on rangeland. The new NRI protocols are designed to detect long-term, years to decades, changes in the condition on rangeland ecosystems, and monitor short-term impacts which may be of immediate concern. A new process-based model was developed by Agricultural Research Service for assessing soil erosion rates on rangelands. The Rangeland Hydrology and Erosion Model was used to calculate runoff and erosion at the hillslope scale for over 10,000 NRI points in the 17 western states on non-federal rangelands. Nationally, 20% of non-federal rangelands generate over 65% of the average annual soil loss. Over 72 million ac (18 %) would likely benefit if it was treated to reduce soil loss to below 1 ton ac⁻¹ year⁻¹. Between 23 and 29% (92 to 106 million ac) of the nation's non-federal rangelands are vulnerable to accelerated soil loss (soil erosion > 1 ton ac⁻¹ year⁻¹) if assessed as a function of vulnerability by using the risk of a runoff event of a given magnitude (25 or 50 year return event). Adoption of the concept of risk and vulnerability will allow land managers to be proactive in preventing accelerated soil loss rather than concentrating on repairing degraded lands which is a far more costly approach.

0073

Regional Research, Demonstration and Extension: The ARS Area-Wide Ecologically Based Invasive Plant Management Project

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The Area-wide project is a collaborative five year effort funded in 2008 by USDA-ARS that has brought together scientists with the USDA-ARS, universities, land managers, and policy makers throughout the Great Basin. A primary goal of the project is to develop and implement a comprehensive, regional ecologically based invasive plant management program to address ecosystems threatened and dominated by cheatgrass and medusahead. Among the activities of this project are landscape-scale demonstration areas with producers in Utah, Idaho, Oregon, Nevada and California. Additional research projects are filling in information gaps, with work ongoing on site history, economics, weather and climate forecasting, seedling establishment, as well as a directed outreach component to develop curriculum, weed prevention areas and user guidelines and support to those managing invasive grasses in the Great Basin. Now into year 3 of the project, the Area-wide project team is making significant progress by increasing awareness of the issue and providing solid integrated management solutions that go beyond addressing the symptoms of annual grass invasions to the true causes of the problem. Education and outreach are important components of the program. Successes of the project can be attributed to having strong communication and support from principal investigators. Several key events were held at the beginning of the project to ensure clear understanding among team members of the ultimate outcomes for the project. Frequent communication and updates are held to keep all team members apprised of the ongoing work on the project.

0074

Ungulate Herbivory as a Chronic Disturbance to Ecosystems

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In the western United States, foraging by wild ungulates has not been recognized as an ecological force as evidenced by the lack of its mention in land management plans. Ungulate herbivory has the potential to influence nutrient cycling and net primary production, and act as a chronic disturbance agent, thereby influencing ecosystem patterns and processes. Ungulates can alter forest successional pathways and disturbance regimes as validated in recent research conducted in northeastern Oregon. Identifying how ungulate herbivory influences composition and structure of forest understories following disturbance is critical to successful forest management. Additionally, herbivory-induced changes in the understory may affect productivity of native ungulate herds and the degree of interspecific competition among ungulates. On the Starkey Experimental Forest and Range, mechanical fuels reduction treatments followed by prescribed burning were applied to mixed conifer forest communities. Treated forests were then fenced and grazed separately by cattle and elk at three stocking levels. Individual shrubs were identified and tagged for monitoring as they emerged. Both shrub density and stem height were greater in the ungrazed versus grazed treatments. There were more shrubs browsed in elk grazed treatments than in cattle grazed treatments although the difference was negligible at the highest ungulate stocking rate. Even at low stocking rates ungulate herbivory was intense on palatable shrub species.

0075

Assessing Climate Change Effects with Indicators for Rangeland Ecosystem Goods, Services and Core Processes

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Much debate continues about climate change. Risk, uncertainty and vulnerability are core themes in these discussions. While there is general agreement that continued increasing concentrations of CO₂ and other greenhouse gases in the atmosphere are altering Earth's climate, the details of how climate change will develop at local scales remain uncertain. Connectivity among ecological, social and economic systems is embodied in rangeland ecosystems goods and services. Therefore, to assess the effects of a changing climate on rangelands and to develop adaptive management strategies, standardized monitoring systems must characterize not only the critical ecological attributes of soils, water, plants, animals, and productive capacities, but also consider attributes which encompass social and economic outcomes, including tradeoffs resulting from climate change. Indicator selection is both an art and a science, with indicator data driving analyses, adaptations and decision-making. Incorporating monitoring into conservation, management, and business plans helps land owners and managers identify and respond to change. Responses may include altered grazing season or rotation, reduction in stocking rate, creation of grass banks, and operation diversification. To enhance understanding of complex ecological and socio-economic interactions, the Sustainable Rangelands Roundtable developed a framework to illustrate interrelationships among social, ecological, and economic concepts. We propose that this framework facilitates evaluation of data across time and provides a powerful analytical tool for managers and policy-makers to consider impacts of climate change on rangelands, as well as to elucidate climate change effects on availability of rangeland ecosystem goods and services desired by the general public.

0076

Evaluation of the Tenderness, Size, and Marbling of Forage-Finished Ribeye Steaks Produced in Kauai County, Hawaii

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Kauai ranchers finish beef cattle entirely on local forages, namely *Panicum maximum*, *Digitaria eriantha*, and *Desmodium* spp. To assess local forage-finished beef quality, we collected 35 paired ribeye steak samples available at retail. After determining ribeye area (REA) and marbling score, we cooked each pair by water bath and grilling methods to reach an internal temperature of 71°C. After cooling to room temperature, we collected from each steak ten 1.3 cm diameter samples cored along the muscle grain. We measured shear force values (SFV) of core samples using Warner-Bratzler blades attached to a TA.XT2 texture analyzer and a G-R unit. Average SFV of samples tested on the TA.XT2 were significantly higher than that of samples tested on the G-R unit in both grilling ($p < 0.004$) and water bath ($p < 0.001$) methods: 4.4 ± 0.3 kg ($\bar{x} \pm \text{SEM}$) versus 3.8 ± 0.2 kg by grilling and 5.7 ± 0.4 kg versus 4.3 ± 0.2 kg by water bath. Within units, grilling results were significantly lower than the water bath average ($p < 0.005$) as measured on the TA.XT2 only. Instruments were significantly correlated ($r^2 = 0.69$, grilling; $r^2 = 0.80$, water bath) as were cooking methods ($r^2 = 0.64$, TA.XT2; $r^2 = 0.40$, G-R). REA averaged 10.0 ± 0.2 in², and the average marbling score was 450 ± 10 or Small⁵⁰. The majority of ribeye steaks from cattle finished on tropical forages in Kauai are smaller than the national average while marbling score and tenderness appear to be within acceptable ranges compared to national data.

0077

Using Ecological Site Descriptions to Guide Sage Grouse Conservation

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When assisting working land owners and managers with planning and ultimately implementation of conservation management on their ranches, decisions related to facilitation or acceleration of sagebrush management such as brush management, prescribed burning or rangeland seeding are now often made using Connelly et al.'s Sage Grouse Guidelines. Because careful interpretation is required to use the guidelines, conservationists and the ranchers must use their experience, knowledge and technical references to navigate the path from management to implementation. Well-developed Ecological Site Descriptions (ESDs) can be an important tool to provide a high level of certainty that the conservation design of planned actions are science-based. ESDs provide: 1) decision support for vegetative management and restoration, 2) performance criteria for management and restoration decisions, and 3) risk assessment for planned accomplishments. The specific utility of ESDs for designing and implementing sage-grouse conservation actions will be discussed more fully.

0078

Monitoring Rangelands with Very-Large Scale Aerial Surveys: Advantages and Limitations

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Rangeland monitoring is, like other scientific investigations, the orderly collection, analysis, and interpretation of data-in this case, resource data for management decisions. Data-collection methods determine data accuracy and inferential power. Reliable tests for ecologically-important change through time, space, or among treatments, must have power; that is, must result from sampling adequate to the questions being asked for the areas of interest. Aerial surveys allow economical extensions of the sampling density and distribution of ground-based monitoring (GBM). Evidence accumulated in testing the efficacy of aerial surveys acquiring very-large scale aerial (VLSA) imagery for uplands, riparian areas, or whole units (allotments, watersheds), show the method is a sampling protocol capable of obtaining the sample density and distribution needed to represent the spatial range of natural variation across extensive areas of interest while providing detail for some key indicators, i.e., bare ground, cover by life form of the first canopy layer. Acquired imagery can be archived for verification of measurements, for trend analysis, and for future, and perhaps unforeseen, uses. Thus, aerial surveys will address the most serious limitations of conventional GBM. However, aerial monitoring should be regarded as an extension of, and not a total replacement for, GBM because: 1) GBM provides critical experience needed to accurately interpret aerial images, 2) repeat aerial surveys recapture only a fraction of first-capture scenes whereas, permanent-plot GBM can provide information on the temporal range of natural variation until longer-term high-resolution image data bases are established, and 3) GBM can provide information on understory vegetation.

0079

Fire in the Sagebrush Biome: An Inherent Process versus Management Tool

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The sagebrush biome characterized by the *A. tridentata* group is a diverse landscape extending from British Columbia to northern Arizona and New Mexico and from the eastern slopes of the Sierra Nevada and Cascade Mountains to western North and South Dakota. Varying geology, topography (elevations ranging from < 300 to > 3,000 m), and climate (ppt zones from 160-250 mm to > 1525 mm) within sagebrush communities creates a diverse mosaic of vegetation across the region. The wide range of vegetation and environmental variables supports a high diversity of fire regimes with mean fire return intervals ranging from a single decade to centuries. Changes in fire regimes, initiated in the late 1800s and early 1900s, shifted the proportion of plant communities between shrub-steppe and grassland and shrub-steppe and woodland. Fire was and still is an inherent component in the biome, however, thoughtful implementation of when and where to apply fire is critical in determining success or failure. The rapid expansion of weeds across the region is closely linked to fire resulting in a significant change in the role of fire from the past. The resilience of sagebrush communities to fire and their resistance to weed encroachment is closely related to soil moisture and temperature regimes. Predicted future climate conditions will result in significant changes in these soil regimes. These changes will be closely linked to fire and other disturbances and disrupters such as, weeds, disease, insects, etc. resulting in an uncertain future for the sagebrush biome.

0080

Social Sciences and Public Rangelands: Perceptions of Bureau of Land Management Employees and Stakeholders

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This paper summarizes the results of a telephone survey of BLM employees and clientele conducted in 2007 and 2008. The goal of the project was to determine the perceptions of employees and public land clientele on the uses of social sciences (economics, sociology, archeology, and other disciplines) in planning and management of BLM rangelands. The employee survey generated 1,251 completed surveys (68% response rate). Sampling and completed surveys were stratified by office location (field/local, state, national) to allow comparisons between those strata. Results indicate that many BLM employees have some educational background and/or training in social sciences, though only about one in four BLM offices currently use trained social scientists to analyze social science data. The survey of stakeholders was stratified by position type (representing the broad categories of commercial, environmental, and public/Tribal interests) on the Resource Advisory Councils. Results generally indicate that stakeholders place high values on the importance of social science information as well as the critical involvement of the public in land use planning and management of natural resources. Results also indicate a high level of awareness about the need for social and economic research and data collection within BLM. A major role of social scientists was identified to be identification of public land users, their usage patterns and their beliefs and priorities for public land management.

0081

Proper Grazing Management During Drought: The Difference between Making a Profit and Losing Your Herd

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The objective of this paper is to report results of proper grazing and beef cattle management on productivity and profitability of a commercial operation in south Texas in an extremely dry year in 2009. The enterprise consists of approximately 40 cows on 146 ha of native grasses with Kleberg bluestem (*Bothriochloa ischaemum*) and bermudagrass (*Cynodon dactylon*). A reduction in stocking rate was done in 2001 (from 1 AU/1.4 ha to at least 1AU/2.3 ha) and maintained in most years from 2003 to 2009. Forage is stockpiled in pastures following rains. Cattle are rotated using 50% of the available forage. Cattle have not been fed hay or cereal grains in over 5 years. Between October 2008 and June 2009, 75 mm of rainfall were received. Based on the amount of stockpiled forage in October 2009, the decision was made to lease 50 ha of additional pastures to decrease grazing pressure. Pregnancy, calving, and weaning rates, as well as weaning weights, did not show major differences between 2008 and 2009. Feed-related expenses increased from \$41 in 2008 to \$185 in 2009, equivalent to a 351% increase. Total expenses increased from \$291 in 2008 compared to \$411 in 2009, and profit per cow decreased from \$252 to \$199. Profit per ha decreased from \$109 to \$64 in 2008 and 2009, respectively. A proper grazing, including moderate stocking rate, stockpiling of forage for winter and droughts, and the flexibility to adjust the grazing program made the difference between making a profit and losing the herd.

0082

Wolves & The Natural Law

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Wolves & The Natural Law will relate historic concepts of The Natural Law from Plato and Thomas Aquinas to the Declaration of Independence and GK Chesterton. When applied to wolves throughout the world today, the role of government consistent with The Natural Law should be composed of four things. First, government should protect human life and property from wolf depredations. Second, decisions regarding the presence or abundance of wolves should be a matter for the lowest level of government, closest to individual communities. Third, wolves should never be imposed or forced on any communities by far-away central governments or urban majorities that are not directly affected by the presence of said wolves. The imposition of wolves by forced introduction is distinguishable from the management of established wolf populations. Fourth, while it is a credit to our humanity that we are concerned about the preservation of plant and animal species, the extension of this concern to creating a deadly threat to humans where none exists, must never be assumed to be legitimate. Wolves kill people as well as destroy human property that in turn ruins families and communities; this is the antithesis of legitimate government. The concepts presented here are as applicable to UN mandates that protect and expand elephant populations which in turn trample African children and destroy African crops as to other national governments and the vacuous philosophies that underpin these violations of The Natural Law, such as "Native Ecosystem Restoration", Wilderness, and "Non-Native Species" eradication programs.

0083

Wolves on the Landscape

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It is understood that large predators such as wolves play an important role in the ecosystem, but whether it's a positive, neutral or negative role is debated. What are the implications of these interactions with the ecosystem? How do wolves influence ecosystem health? Can wolves co-exist on a working landscape where management objectives include a healthy ungulate population and livestock grazing? These questions not only complicate matters for managers trying to increase habitat quality, but encourage a reactive approach to management of wolves that emphasizes the depth of the problem rather than the nature of the solution. With the listing, de-listing and subsequent re-listing of Grey wolves in the USA the issues surrounding wolf management have escalated. Are there opportunities to learn from other jurisdictions such as Canada to assist in wolf management? This symposium is an attempt to gather key individuals to discuss current research, ideas and possible solutions to wolf problems and hopefully direct or assist future management.

0084

Harvest Efficiency of High Stocking Density Grazing

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High stocking density grazing or "mob" grazing is a recent phenomenon that is being promoted by a few practitioners, but has not undergone rigorous scientific testing. The objective of this study was to determine the harvest efficiency of cattle grazing at high stocking densities. The study was conducted in July and August 2010 at the University of Nebraska-Lincoln (UNL) Barta Brothers Ranch located in the eastern Sandhills near Basset, Nebraska and at the South Dakota State University (SDSU) Cow-calf Unit in east-central South Dakota located near Brookings, South Dakota. The vegetation at the UNL and SDSU sites was predominantly introduced cool-season grasses on a wet meadow and upland silty clay loam site, respectively. Twice replicated yearling steer stocking densities of 224,000 kg of live weight per ha were achieved in small paddocks and moved twice daily at each location. Hand-clipped vegetation estimates of biomass pre- and post-grazing were used to calculate available forage, grazing pressure, and harvest efficiency. Average forage available was 6100 and 4400 kg/ha and resulted in an average grazing pressure of 40 and 55 AUD/Mg at the UNL and SDSU sites, respectively. Harvest efficiency of 35 and 40% was achieved at the UNL and SDSU sites, respectively. A linear relationship between grazing pressure and harvest efficiency ($16.8 + 0.43 \times \text{grazing pressure}$; $R^2=0.38$) was found. This equation is a useful way to estimate daily livestock consumption for planning purposes to estimate the size of paddock and number of daily moves required to manage high stocking density grazing.

0085

Improvement of Seed Production in Utah Sweetvetch

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Sweetvetch (*Hedysarum boreale* Nutt. [Fabaceae]) is sought for use in seeding for rangeland improvement and reclamation. The use of sweetvetch is limited by poor seed production due to lack of seed set and excessive shattering. Neither improved genetic material nor descriptions of management practices to improve seed set and reduce shattering have been described. Seed set and shattering are under genetic control but highly influenced by environment. Our work to increase seed production has focused on improved seed set and reduced seed shattering through recurrent selection and management practices including insect control and irrigation during seed maturation. Three cycles of recurrent selection for improved seed production within a broad based gene pool has been completed. Work on irrigation has shown that proper timing provides an increase in seed production but excessive irrigation can be counterproductive. Insect control during seed development can eliminate infestations of harvested seed. The combination of improved germplasm and appropriate management has resulted in a several fold increase in seed production of sweetvetch.

0086

Breeding Strategies for the Development of Bluebunch Wheatgrass for the Great Basin

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Bluebunch wheatgrass is an important native species used in many reseeding efforts of the Great Basin; however, the varieties used in these reseedings usually originate from the Palouse region. The increased interest to restore rangelands using regionally-adapted plant germplasm necessitates the development of Great Basin ecosystem-originated bluebunch wheatgrass. However, the dramatic and substantial degradation of this region, caused by invasive weeds and changed fire regimes, will seriously challenge the successful use of "local" seed sources and pre-variety germplasms. This paper will discuss the strategies being employed in the ongoing development of Great Basin-originated bluebunch wheatgrass varieties that maintain regionally-adapted genetic diversity, but have improved seed yield, seedling establishment, and persistence.

0087

Remote Sensing of Plant Community Dynamics in a Sandhills Blowout

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Nebraska Sandhills are unique to the Great Plains in that they occur in a semi-arid sand dune complex. Presently, this complex is largely stabilized by mixed grass prairie but areas of sparse vegetation result from various disturbances, such as improper grazing, fire, or drought. Strong winds, not uncommon to this region, have the propensity to mobilize the sparsely vegetated dune sand, creating denuded hollows termed blowouts. However, little is documented about the re-vegetation patterns of blowouts, the influence of climatic variables on these patterns, and the general persistence of blowouts on the landscape. This study determined the best approach to utilize remote sensing techniques and long-term vegetation data to track plant community changes within blowouts. Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) scenes were used in conjunction with 30 years (1981 to 2010) of ground-truth data to determine the best spectral vegetation index to use for this system. Plant communities were classified using a normalized difference vegetation index (NDVI) and soil-adjusted vegetation index (SAVI). A confusion matrix was used to determine the accuracy of plant community classification. Overall, NDVI was the most accurate (64.9%) vegetation index for classifying plant communities within the blowout, followed by SAVI (39.24%). Future analysis will use NDVI to track long-term, landscape scale patterns of blowouts across the Sandhills.

0088

Sage Grouse Initiative - NRCS, Washington State

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How is Washington's sage grouse habitat different from other states? The biggest difference is land use. The Columbia Basin sub-population of sage grouse thrives on the agricultural landscape of Eastern Washington. Sage grouse in Washington co-exist with farmers, not ranchers. According to the Washington Department of Fish & Wildlife, the 2009 population estimates were at 700 birds. The 2010 estimates are over 1100. In the 1990s, Douglas County, Washington was allowed to exceed its twenty-five percent cap for the Conservation Reserve Program (CRP). By 2005 over half of the sage grouse nests recorded in Washington State were on CRP. Douglas County can no longer exceed the twenty-five percent cap of 40,000 acres of CRP. Some of the expiring CRP is being mowed, tilled and cropped. Our goal for the Sage Grouse Initiative and additional funds through the Environmental Quality Incentives Program (EQIP) is to extend CRP contracts by paying for forgone income on expiring CRP for a period of up to three years. After three years, we hope that much of the expiring CRP can be re-enrolled in a CRP program administered by the State called SAFE, State Acres For Enhancement. In May of 2010, 38,000 acres of SAFE were authorized for enrollment. These acres are in addition to the acres already enrolled through the Sage Grouse Initiative and EQIP. These two programs promise to help protect sage grouse habitat for the next 3 to 15 years.

0089

Bison and Cattle: How Different Are They?

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Herbivory is an important ecosystem process recognized by both ecologists and land managers. The Great Plains of North America evolved with significant influence from bison (*Bison bison*), but is presently dominated by cattle (*Bos taurus*, *B. indicus*). While there is a variety of dogma concerning differences between these two species, there is a lack of scientific comparisons that incorporate important ecological variation. We developed a framework to compare bison and cattle that includes environmental complexity; we used this framework to compare the grazing behavior of both species in tallgrass prairie. We present this study as an example of how bison and cattle should be compared. We collared seven bison and cattle individuals with global positioning systems and recorded location information at various frequencies. Using resource selection functions, we estimated the importance of various environmental factors on site selection. Both species preferred recently burned areas and avoided steeper slopes. Cattle selected areas that were closer to water, while bison were not limited by distance to water; cattle also preferred areas with woody vegetation, while bison avoided them. Incorporating environmental complexity allows for an effective comparison of ecological differences between bison and cattle. There is not enough data to confidently state that bison or cattle are better for overall conservation or biodiversity. As more studies effectively compare grazing behavior and the effects of bison and cattle, reliable conclusions can be made to direct conservation and management efforts.

0090

Seed Production of Native Plants in the Intermountain West

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The USDA-NRCS Plant Materials Center (PMC) in Aberdeen, Idaho has been testing, selecting and releasing plants to help solve natural resource issues since 1939. The PMC has developed a number of unique methods and tools to produce seed from native species. Weed barrier fabric is used to control weeds from select native forb and shrub seed production fields. A new harvesting machine developed by the PMC termed the "jet harvester", quickly and easily removes ripe seed with reduced inert material and is non-destructive to the seed-producing plant. The PMC has also developed a quick method to estimate seed quality during seed processing using a hot plate heated by propane.

0091

SRR Rangeland Ecosystem Services Assessment Framework

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Ecosystem goods and services (EGS) are those things that humans value that are derived or part of the natural world. We define these EGS as extractable goods or tangible or intangible services. The Sustainable Rangeland Roundtable (SRR) has developed a set of questions to narrow the list of EGSs that should be considered when evaluating whether rangelands are being managed sustainably. The process takes into account the "must have" criteria followed by the "wants" of society. The intent is to help prioritize which EGS should be considered in a particular situation. Initial tests of the framework indicate that it is a useful way to organize the important aspects of an ecosystem good or service. The process would allow a decision-maker to rank the different goods and services according to importance, response to management, and other characteristics.

0092

SRR Socio-Economic Assessment Indicators

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The Sustainable Rangeland Roundtable has as its mission to promote the use of ecological, social, and economic indicators of sustainability. These "three legs of the sustainability stool" must be in rough balance for a system to be considered sustainable. In this section, we will examine the social and economic indicators for use in a ranch planning framework. There are only a few indicators that would need to be measured and monitored over time. However, there are many questions that a ranch family should ask themselves related to what their individual, family, and business goals are. The answer to these kinds of questions provides the context within which the social and economic monitoring data can be interpreted.

0093

Factors Limiting Use of Drought Mitigation Tactics among Utah Cattle Ranchers

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Despite the importance of drought, there has been relatively little detailed research concerning drought management and ranching. Recent work in Utah has assessed drought readiness among ranchers during 1998-2009. One finding was that 14 drought mitigation tactics appeared underutilized across the population, but it was unclear why. Objectives for this research were to determine factors limiting further adoption of drought mitigation tactics and how constraints might be overcome. Tactics included use of water development, stocking rate reduction, income diversification, government programs, hay production, hay storage, bank loan renegotiation, grass banks, forward contracting, weather forecasts, livestock or feed insurance, and extension information. A phone and mail survey was implemented among 456 ranchers during winter 2010 using a simple-random design. The response rate was 88%. Except for people contemplating grass banks, substantial portions of other respondents (23 to 63%) said they had little or no need for the remaining tactics, suggesting that most would be well under 100% adoption regardless of incentives or outreach education. Lack of awareness—and ecological limitations—were perceived as major constraints in some cases. Thirteen to twenty-four percent of respondents noted cost as the major constraint for water development, stocking rate reduction, hay storage, and procuring insurance. Weather forecasts had very low utility for drought planning (65% of respondents). Nearly one-third of respondents were retirees with little motivation to diversify incomes. In conclusion, while subsidization or expanded outreach education might stimulate further adoption of a few tactics, in most cases demand largely appears to have been met.

0094

Cheatgrass Dead Zones in Northern Nevada

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Reports of areas of cheatgrass die-off are becoming more frequent. In 2009, we investigated cheatgrass die off in north-central Nevada. Dead zones ranged from several to hundreds of acres in size and were largely unvegetated and covered by cheatgrass litter with a distinct gray cast. We collected replicate soil samples inside the dead zones and adjacent non-affected areas and analyzed for soil nutrients, and growth of newly planted cheatgrass seeds in both control and autoclaved soils. Newly planted cheatgrass produced statistically similar above-ground biomass after 40 days in both affected and non-affected soil and autoclaving did not influence cheatgrass growth. Most nutrients measures were statistically similar in and out of dead zones, but soil from dead zones has significantly greater mineral N and sulfate. Moreover, both zones contained large germinable seedbanks of cheatgrass. At this time we cannot explain the cause of cheatgrass die-off, but clearly this is an important process deserving of more research.

0095

Look Closer: Time Sequence Photography of Roosters Comb in the Sheep Creek Range

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Recognizing natural landscape change is key in properly understanding rangeland ecology. Time sequence photography allows the comparison of natural changes overtime. Photographs of Roosters Comb were taken from the same vantage point in the spring and fall from 2004 to 2010. Annual climate variations caused dramatic fluctuations in species composition, plant biomass, and the "look" of the landscape. Without photographic evidence, our memories or perceptions of what we have seen could become distorted. However, reviewing past photography before making ecological or management decisions may contribute to different insights.

0096

The Right Conservation in the Right Places: Using Sage-Grouse Core Areas to Target SGI Resources

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An expanding human footprint in the West makes 'conservation triage' unavoidable, and sage-grouse declines have partners searching for innovative ways to receive the biggest biological return on their conservation investment. The Sage Grouse Initiative (SGI) aims to target NRCS programs to landscapes where the right conservation practices will provide the biggest benefits to sage-grouse populations. SGI's targeting strategy is founded in range-wide sage-grouse 'core areas' that represent locations of high abundance population centers containing a majority of birds. We used lek-count data (n = 4,885 leks) to delineate core areas containing 25, 50, 75, and 100% of known breeding populations. Findings show bird abundance is highly clumped from range-wide to state-level scales. Cores contain 25% of the populations within 4% (7.2 million ac) of the range, and 75% of birds are concentrated within 54% of their distribution. Abundance varies by Sage-grouse Management Zones, with Zones I, II, and IV containing 83.7% of all known sage-grouse. Conservation priorities are widespread with each of 11 states containing ≥ 1 cores with enough breeding birds to meet the 75% abundance threshold. Surface ownership within 75% core areas is 44% Federal, 36% private, and 5% State lands. Cores provide a mechanism for SGI to prioritize conservation, but risks and opportunities vary across states and provinces. More importantly, state game and fish agencies responsible for sage-grouse management have site scale knowledge of seasonal habitat needs outside the breeding season and other data useful in decision-making. We encourage federal agencies and other partners to consult state agencies to coordinate implementation.

0097

Setting the Bar High: Using Science to Evaluate SGI Conservation Outcomes

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USDA leadership is committed to quantifying sage-grouse response to NRCS conservation practices through a coordinated framework that informs adaptive management of program delivery. Rather than focus on acres treated, SGI's approach is biologically-based and uses sage-grouse population and habitat responses at multiple scales to evaluate program benefits. To date, we have assembled >\$500K in dedicated research funds and initiated outcome assessments in core areas in Oregon and Montana. In south-central Oregon, SGI is reducing the fragmentation threat of encroached juniper in the state's largest core area. Private landowners and BLM are removing post-settlement juniper on 27,000 ac over 5 years. The University of Idaho in cooperation with Oregon Department of Fish and Wildlife has designed a before-after control-impact study and radio-marked sage-grouse to evaluate bird response to juniper removal. In Montana, SGI has secured commitments with 8 producers on 70,000 ac in a core area near Billings, to manage stocking rates commensurate with capacity and to rotate deferred grazing in 20-30% of pastures identified as nesting habitat as part of a rest rotation grazing system. Partners from Montana's Department of Fish, Wildlife and Parks and the University of Montana are co-investigating efficacy of grazing systems using vital rates of radio-marked grouse and lek counts as an index to population size. SGI envisions ~15 assessment projects located throughout the species range where SGI has focused its resources. SGI will compile scientific outcomes from studies into a comprehensive assessment of range-wide contributions to sage-grouse conservation to inform Endangered Species Act listing officials and adaptively improve SGI.

0098

Success Using an Interdisciplinary Approach for Watershed-Scale Land Health Assessments and Subsequent Project Implementation

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Prior to 2002, land health assessments conducted by the Dillon Field Office (DFO) grouped grazing allotments by permittee/lessee and emphasized grazing permit/lease renewal. Since 2002, assessments are based on fifth-level Hydrologic Unit Code (HUC 5) watersheds, include multiple programs (e.g., range, weeds, hydrology, wildlife, fisheries, forestry, fuels, minerals, lands, wilderness, and recreation), and focus on land health and enhancing biodiversity at the landscape level. Interdisciplinary team (IDT) members are assigned by the field manager and the assessment dates are identified six months in advance. This approach creates a number of efficiencies during the assessment and implementation processes. During assessments, the IDT improves logistical efficiency by visiting multiple sites in adjacent areas. Participation by the entire IDT results in a more thorough understanding of ecological processes within the watershed, more intimate knowledge of other disciplines and their projects, better cumulative impacts analysis, strong internal support of environmental assessments (EA) and decisions, team building, and employee empowerment. Furthermore, preparing a single EA for all allotments within the watershed better utilizes specialists' time and reduces the opportunity for appeal, allowing for more time in the field. Between 2002 and 2010, the DFO assessed 15 watersheds, covering 363 grazing allotments and about 750,000 BLM acres, and analyzed potential impacts from management changes and projects in only 17 EAs. Post-decision benefits include a greater number of NEPA-compliant projects that are ready to implement, resource accomplishments that vastly exceed the cumulative accomplishments of individual IDT members, and a more defensible position in the event of an appeal.

0099

Rangelands West Goes International: Introducing *Global Rangelands*

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With funding from the NIFA International Science and Education program, a collaboration involving members of the Western Rangelands Partnership (University of Arizona, University of California-Davis, and University of Idaho), the Food and Agriculture Organization of the United Nations (FAO), and Rangelands Australia, is in the process of developing a comprehensive Global Rangelands Online Knowledge System (Global Rangelands). This presentation will describe the two-year project and provide a demonstration of the results achieved so far. Specifically, the new Global Rangelands system will provide access to international resources on sustainable rangeland management through redesign and expansion of the current Rangelands West portal, and through the eXtension Rangelands website. Online services will include: 1) a fully searchable international repository of full-text articles, documents, images, and multi-media teaching, learning, and outreach materials on rangeland topics, 2) applications to facilitate expanded knowledge of international work in rangeland research, teaching, and extension, 3) multi-media learning modules on global rangelands, 4) synthesis documents on aspects of international outreach practices relevant to Extension programming, and 5) a customized search interface that improves access to critical rangelands information and encourages direct user engagement in the Global Rangelands system.

0100

Rangelands on eXtension: Compiling the Best of the Best for Rangelands

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In response to the need to provide objective, science-based information via the internet, in 2009 a group of rangeland specialists, range faculty and librarians from 19 western states came together to initiate a "Rangeland Stewardship and Health" Community of Practice (CoP) for eXtension.org. According to eXtension.org, a CoP is: "an evolving, virtual, customer-centered educational environment that will provide the most current, objective, research-based information from the Land Grant University System for anyone, at any time, on any device, and in any location." The Rangelands Stewardship and Health Community of Practice was created to meet the educational and decision-making needs of public and private rangeland managers, allied industry partners, extension employees, and consumers by providing synthesized science-based information and learning opportunities. The Rangelands CoP hosts FAQs, Ask an Expert service, a glossary of rangeland terms, a calendar of rangeland events, RSS feeds, and content pages delivering information on a variety of rangeland topics. Articles are written for the general public and/or land manager or rancher where the purpose is to get practical information for decision-making or to provide basic/introductory education. Links are provided to full text articles and peer reviewed materials representing the "best of the best" in rangeland information from the entire land-grant system. Countless opportunities exist for other rangeland professionals to join and participate in the CoP to develop educational materials and learning opportunities that address the needs of all segments of the field of rangeland ecology and management in a variety of formats.

0101

Internet Technologies for Rangeland Ambassadors

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When was the last time you told someone that you work on rangelands only to have them bestow a look of confusion in return? As a rangeland professional, you are an ambassador for these vast landscapes that "fill the void" between urban areas, and which are often overlooked and seldom understood. An ambassador has power to make people look on rangelands with a sense of wonder - like when they look at the stars or the ocean. There are many internet technologies that can be harnessed to help you introduce rangelands to anyone who is interested in learning more. However, becoming proficient with these tools can be an overwhelming undertaking for someone who neither possesses the technical aptitude nor the time to decipher what might be most useful and engaging for their audience. This is particularly true when informing younger audiences because the millennial generation is fascinated with technology and their comfort level often surpasses that of their elders. We will showcase a number of internet-based tools and resources to explore rangeland ecosystems including virtual tours, interactive photos, videos, Google Earth resources, and other new media technologies that engage a variety of audiences. We will also feature resources that are available to aid you when you are asked to present information about rangelands to a local civic organization, volunteer service group, high school classroom, or other education setting. Internet resources about rangelands are there to help. We will empower you with a suite of new media tools and existing presentation resources.

0102

The Rangeland Science Database: A Search Engine for Range Professionals

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Rangeland professionals are busy people that need access to the best scientific information for specific topics quickly and easily. While Google® has changed the way we find information on nearly everything in life, unfortunately, there is no Google Rangelands. Enter the Rangeland Science Database, a collection of over 1,300 bibliographic citations to articles and documents focused on: riparian, weeds, rangeland, wildlife, vegetation, and soils research. This growing collaboration between researchers is more than a full text database, with all citations annotated by experts in the field of range management. This allows range professionals to find relevant information quickly without becoming lost in a sea of unrelated information. Come learn how to browse, search, and contribute to this emerging dataset.

0103

A Lifetime of Research and Observations Preserved: The August "Gus" Hormay Collection Available Online

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Take a look back into range science history via the scientific information recorded by August "Gus" Ludwig Hormay using the quaint methods of pencil and paper. Often referred to as the "Father of Rest-Rotation Grazing" Gus Hormay (1907-1999) developed rest-rotation grazing systems for the management of rangelands in the Western United States during more than seventy years of work in natural resource conservation. This special collection housed at the Montana State University Library chronicles the life and career of Mr. Hormay. The collection features extensive outgoing and incoming correspondence, in addition to calendars and diaries that document his daily activities. Users can access summaries and statistics of all rest-rotation grazing allotments visited or analyzed by Hormay, and geographically arranged record files containing information on individual allotments throughout the western United States. Hormay's work in the national forests of northeastern California and rangelands throughout the western region of the United States is extensively documented through his working notes and file collection. We will take a brief tour of the online, searchable, full-text retrieval digital collection of Gus Hormay's professional papers on rest-rotation, and his carefully recorded laboratory research, field observations, and contribution to the knowledge base of range science.

0104

Analyzing the Effect of Slope Aspect and Phenology on Biomass Production in Western South Dakota Grasslands Using MODIS NDVI

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Remote sensing NDVI techniques have a long track record of providing timely and accurate results over large study areas with minimal sampling effort. Assessment of rangeland productivity and phenology using this technology provides multiple [up to weekly] measurements of vegetative productivity greatly increasing the ability to track patterns in production as compared to traditional field sampling measurements. The objective of this study was to evaluate the utility of MODIS NDVI satellite data to examine effects of slope aspect and phenology on biomass production in western South Dakota rangelands. MODIS satellite NDVI data for 2000-2009 was obtained for the Bad River watershed in west-central South Dakota. The study area (approximately 820,000 hectares) largely consists of rangelands with production dominated by cool season genera such as *Stipa* and *Pascopyrum*. Sample points [pixels] (n= 2000) were randomly placed across the study area satellite images. At each point the aspect and growing season (April-September) average NDVI was sampled using GIS. Phenology of maximum biomass was observed at sites (n= 50) sorted by aspect. North facing aspects displayed higher biomass production than south facing slopes and reached seasonal peak production about one week sooner. Drought years displayed significantly delayed (5-6 weeks later than average) peak biomass production as warm season plants were better able to tolerate drought stress.

0105

Sustainable Ranch Management through Business Planning and Rangeland Monitoring

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This session is designed to teach conservation professionals, extension personnel and land managers about combining social, ecological and economic monitoring with standard business planning methods for sustainable ranch management. The workshop will discuss how selected social, ecological, and economic indicators can be used to monitor ecological conditions as well as the socio-economic components of a ranch business plan. The business planning process and the protocols needed to gather necessary monitoring data will be presented. Speakers will provide an overview of sustainability principles at the ranch level, emphasizing integration of economic, social, and economic information. Applications on federal allotments, as well as within the NRCS conservation planning context for private lands will be addressed. A section will deal specifically with collection of traditional monitoring data for soils, water, plant, animals, productive capacities, economics, and relevant social, legal, and institutional elements. A framework for evaluation of rangeland ecosystem services for alternative income streams also will be presented. The Wyoming Business Council process for developing a ranch business plan, including all requisite materials, will be featured. By the end of this workshop, participants should be able to assist ranchers in developing a business plan, including monitoring necessary to support sound decision-making for financial and natural resource related aspects of the business. Depending on attendance, participants may be able to discuss pros and cons of ecological and financial monitoring and business planning with ranchers involved in the process.

0106

Comparing the Impacts of Water Quality Regulations on Land Use in Two Watersheds: Lake Taupo (NZ) and Tomales Bay, California (USA)

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Livestock grazing in the United States and New Zealand is increasingly being scrutinized for its environmental impact. In some regions regulations intended to reduce non-point pollution have been introduced. Regulations can impact the sustainability of livestock grazing enterprises and may have undesirable consequences including land use change. Livestock producers in two watersheds, Lake Taupo (New Zealand) and Tomales Bay (California), were interviewed regarding impacts of new water quality regulations on livestock enterprise sustainability. The interviews identified motivations for ranching/livestock grazing and incentives improving water quality while maintaining livestock grazing enterprises. The impact of a market-based strategy to reduce and cap N leaching in the Lake Taupo watershed seems to be resulting in fewer but more intensive livestock grazing operations. Concerns of future sustainability have driven some producers in the watershed to sell their farms. The Tomales Bay catchment strategy, which requires self-assessment of grazing land water quality impacts, is resulting in most producers initiating new conservation practices with little short-term impact to sustainability. Regulations that go beyond market-based incentives and include substantial technical assistance and cost-share incentives may be more effective at providing opportunities for sustaining less intensive livestock grazing enterprises and maintaining compatible watershed land uses.

0107

Historical Global Fire Context: Linking Landscapes and Ecosystems

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Rangeland ecosystems evolved with relatively frequent fire and thus the biotic ecosystem components are well adapted and often dependent on fire as a driver of ecosystem function. Following European settlement, fire was suppressed and all but removed from much of the North American landscape often altering key ecosystem properties. A number of scientists and land managers are experimenting with fire to discover key variables that are necessary to support the use of fire on rangeland ecosystems. However, one barrier to successful implementation of a fire regime is the view of fire as a management tool often applied once rather than as a regime over time. This treatment view of fire suggests that is acceptably interchangeable with grazing, herbicides and mechanical disturbance, rather than an integral ecosystem process and keystone disturbance just as vital to an ecosystem as soil type and precipitation. A summary of fire research reveals that much of our knowledge of fire is limited to short duration and small or non-replicated experiments. The need for larger and longer duration studies is evident if we want fire to be a relevant process in rangeland ecosystems.

0108

Ability to Extract Soil N at High Temperatures Allows Cheatgrass to Exclude Perennial Grasses

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In the Intermountain West of the USA, Cheatgrass (*Bromus tectorum*) forms dense monospecific stands following disturbance, and establishment of native perennials into these stands is exceedingly difficult. Performance differences between native and exotic plants is one hypothesis to explain invasive plant success. As an invasive winter annual grass, cheatgrass may trade-off lifespan for short-term resource capture enabling greater performance than competing native perennial species. In addition, cheatgrass germinates in the autumn and senesces prior to hot, dry summer conditions; perennials germinate in the spring and persist through the summer. We tested the hypothesis that a primary mechanism; whereby cheatgrass maintains dominance and excludes native species, is through rapidly acquiring soil N in spring. We grew both cheatgrass and perennial species under various temperature conditions representative of spring and measured N uptake rate. We found similar rates of N uptake by cheatgrass and perennial species at low temperatures, but exceptional uptake by cheatgrass at high temperature. Cheatgrass was also the most plastic species in N uptake, capable of taking advantage of optimal growing conditions when they occurred, while perennial grasses were more conservative in resource capture. Despite cheatgrass being a winter annual, it did not perform better than perennials under cool conditions. Rather, cheatgrass may exclude perennials by rapidly acquiring N in the late spring when conditions are warm. Consequently, the early germination of cheatgrass does not confer a resource capture advantage but early deployment of roots may allow rapid N uptake when soils warm.

0109

Prescribed Burn Associations: Getting Landowners to Use Prescribed Fire

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Landowners usually give four reasons why they do not burn when asked about conducting prescribed fires, they are liability, lack of training, lack of equipment and lack of labor. There are several ways these obstacles can be overcome, but more often than not it makes prescribed burning a more costly or unattainable venture. Through the formation of local prescribed burn associations in Oklahoma, many private land managers are able to overcome these barriers, and at the same time safely and effectively apply fire to their land. These associations are started by involving interested citizens from the surrounding community and allowing local extension and conservation district employees to provide technical assistance to the group. The association elects leaders, sets goals and guidelines, along with an area to work in. One of the main attributes of a prescribed burning association is its neighbor helping neighbor approach. It also gives people hands-on experience along with organized training. When a group of like minded citizens band together into an association there is more land that can be safely burned and it creates an organization that has strength in numbers when it comes to promoting fire or finding funding for equipment. Currently there are 16 burn associations in Oklahoma, covering 30 counties, with over 300 members. In the spring of 2008 six of these associations safely burned nearly 50,000 acres.

0110

Research and Management Priorities and Strategies for Sustaining Great Basin Ecosystems

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Semi-arid rangelands across the globe are undergoing major ecological and socioeconomic changes. In many areas, these changes have detrimental effects on the structure, composition and function of native ecosystems and jeopardize ecosystem services. In the Great Basin of the western United States, causes of change are highly interactive and include human population growth, past and present land uses, climate change, altered fire regimes, and rapid expansion of invasive species. Cumulative effects include vegetation type conversions, loss of watershed functioning, loss of native species, and diminished economic potential. Addressing this ongoing change requires new and innovative research and management approaches that are based on an understanding of ecological resilience to disturbance and resistance to invasion, and that are focused on larger spatial scales and longer time frames than in the past. Basic research coupled with large-scale assessments and effective monitoring strategies are needed to track the ongoing changes. Prediction and modeling of alternative futures are needed that can be incorporated into planning processes and used as a basis for adaptive management. Altering current trajectories will require mechanisms for building consensus among all stakeholders, acquiring the necessary financial resources and political support, and implementing effective policies and institutional mechanisms for management actions. Strong collaborative partnerships among the region's researchers, managers and stakeholders are essential for sustaining the ecosystems, resources and human populations of the Great Basin.

0111

Native Grasses Evaluation for Reseedings in Northeast Mexico

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Northeast Mexico is part of the Tamaulipan Biotic Province, a semiarid sub tropical and tropical land where beef cattle industry under grazing conditions is one of the most important enterprises. The increase of woody vegetation on rangelands during the last century has reduced the forage production and carrying capacity. Ranchers have established exotic grasses as buffelgrass (*Cenchrus ciliaris*), bermudagrass (*Cynodon dactylon*), angletongrass (*Dichanthium aristatum*), stargrass (*Cynodon plectostachyus*), and guineagrass (*Panicum maximum*); supposedly because they produce more biomass than native grasses. However, there is insufficient information comparing production between grass types. On the other hand, environmentalists have concerns about the invasive behavior of exotic plants. Considering the lack of information, a study was carried out in Tamaulipas State, Mexico to evaluate the establishment and biomass production of native grasses. Climate is subhumid with 24°C, 900 mm average annual rainfall, and heavy clay soils. The summer of 2009 were seeded the grasses: hooded windmillgrass (*Chloris cucullata*), side oats grama (*Bouteloua curtipendula*), windmillgrass (*Chloris truncata*), switchgrass (*Panicum virgatum*), and bristlegrass (*Setaria macrostachia*) in 4X5 m plots using a randomized complete block design with four replications. No fertilizer or irrigation was applied. After the first growing season an analysis of variance was conducted on variables height and yield. Differences were found ($P < 0.05$) with grasses of greater yield were side oats grama and windmillgrass at 3709, and 4673 kg dry matter ha⁻¹; respectively. The highest grass was windmillgrass with 77 cm followed by switchgrass (73 cm). So far, native grasses show potential for grasslands reseeding.

0112

Weather or Not: Changes in Grazed and Ungrazed Great Plains Grassland Plant Communities Associated with Interannual Variability in Weather

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In many studies, interannual variability in plant communities not attributable to experimental treatments, such as fire or ungulate grazing, is often attributed to the effects of weather. However, few studies have actually examined the relationship between weather and changes in plant community composition. Using existing datasets from grazed and ungrazed shortgrass and tallgrass prairies in Kansas, we assessed the effects of weather on interannual variability in plant communities. We used an information theoretic approach to examine the impacts of weather on plant species richness and diversity. We also conducted fourcorner analyses to assess changes in the functional characteristics (nativity, presence of horizontal stems, season of active growth, growth form, and life cycle) of the plant communities associated with weather. The fit of the relationships between weather and plant community composition was generally stronger in grazed than ungrazed areas. Summer temperature was associated with changes in native richness in both short- and tallgrass prairies, regardless of grazing. Responses of plant communities to interannual weather was primarily due to shifts in species based on the presence of a horizontal stem (rhizomes or stolons) or the season of active growth (cool- versus warm- season species). By altering species composition, our results indicate that management practices, such as grazing, can also change how the community responds to temporal variability in weather. Our results also suggest that plant communities are affected by weather in complex ways that need further study given current and projected changes in climate in the Great Plains.

0113

The Williamson Cattle Company - Florida Environmental Stewardship Award Winner 2010

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The Williamson Cattle Company, located in Okeechobee, FL, is a family owned and operated agriculture business that was started in the 1940's. Founded by Frank Williamson Sr., the business now boasts three generations of family working on the 8,500 ac ranch. Frank "Wes" Williamson believes in being good stewards of the land and incorporates wildlife management into all the ranch decisions. They leave the wooded areas and plant legumes for the deer and other wildlife. The Williamson Cattle Company was also one of three ranches to pioneer the Florida Ranchlands Environmental Services Project (FRESP). This project allows a state agency to pay ranchers for providing documented water and phosphorus-retention services over a fixed-term contract. This public/private partnership allows the landowner to provide this service instead of taking the land out of the tax rolls and placing it into local/state government control. Currently, the Williamsons manage a Brangus herd. The Williamsons husbandry of cattle does not stop at the sale like most ranchers in South Florida, but extends throughout the animals life. The Williamsons select all replacement heifers from within their herd to ensure good genetic traits of cattle that can both survive and consistently raise healthy calves yearly on the ranch. The Williamsons are constantly working on improving and lightening their impacts on the land. They are continually working on the use of implementing better technology, newer research, and have been very outspoken in the role of maintaining a healthy habitat not only for cattle but wildlife as well.

0114

Texas GLCI - Growing Partnerships in Texas

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The Texas Coalition of the Grazing Lands Conservation Initiative is an “organization of organizations” and individuals who want to foster the stewardship of privately owned grazing lands. They are not doing it alone. They serve a facilitating role to bring others together to get things done. To accomplish their goal of stewardship on grazing lands, Texas has several GLCI regions to stay even more locally focused. Most of their efforts revolve around education of not only the technical aspects of grazing lands stewardship, but also sound economics and personal goals. The result has been increased participation in workshops and tours. GLCI has also been asked to be a partner in an increasing number of grazing lands resource-related events. Some of these include working with local county officials on burn ban issues, tours, conferences, presentations, plant identification books, Texas record book, rangeland hydrology projects, a Grazing Land Stewardship Manual and promotional material such as pasture sticks. GLCI leads the Coastal Prairies Conservation Initiative between partners such as ranchers, Fish and Wildlife Service, The Nature Conservancy and Texas Parks and Wildlife Department. This is an endeavor to restore coastal prairies and re-introduce the Attwater’s prairie chickens. The Coastal Prairies GLCI is the holder of Safe Harbor Agreements. Numerous other educational/training events include low stress handling of livestock, prescribed burning, grazing management, brush control, enterprise diversification, inventorying and related topics. Bringing people together to identify problems then working toward solutions is the Texas GLCI process.

0115

Using Low-Stress, Pressure-and-Release Tactics and Attractants to Move Producers to a Better Place in the NRCS

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In recent years, management-oriented USDA-NRCS technical assistance has often been de-emphasized in favor of a program-driven emphasis, measuring success by the number of cost-shared hardware items installed, which may provide few ecological benefits. To break this cycle, the NRCS rangeland program in southeastern Colorado focuses on first helping producers identify pressures on their business. Then we use attractants like incentive payments, and a simple, goal-based process to help them identify for themselves options for relieving that pressure through improved MANAGEMENT. The management approach emphasizes manipulation of natural processes through grazing deferment and improved distribution, with structural practices as the means to achieve that end. Important keys to success include: 1) use "teachable moments" to help them see possibilities, 2) start with the final product in mind, 3) always make the right action easy, 4) ALWAYS provide multiple options, 5) ranchers learn best from other ranchers, 7) don't just describe success, demonstrate it, and 8) there is no such thing as insignificant progress. The result of this effort has allowed us to increase the number of contracts, reduce the number modifications required, and increase the amount of unsolicited producer requests for management assistance. In addition, the use of rangeland monitoring, improved grazing management strategies, greater species and structural diversity, and improved watershed function are increasing on the land over which we have some influence. It has also provided a "critical mass" of innovative and INFLUENTIAL producers that are leaders in spreading the gospel of conservation-friendly management of rangeland.

0116

Effect of Management Practices on Spatial Utilization by Cattle (*Bos* spp.) on Rangeland in South Florida

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Fragmentation of rangeland communities in South Florida by human encroachment has resulted in the suppression or elimination of natural fire. Consequently, the remaining rangeland acreage in South Florida can get overgrown very quickly with woody species such as wax myrtle (*Morella cerifera*), saw palmetto (*Serenoa repens*), and fetterbush (*Lyonia lucida*) unless management practices are introduced into the ecology of the site. When rangeland is overgrown, populations of wildlife species such as quail and song birds are reduced due to loss of foraging and nesting habitat. Concomitant with such habitat changes, utilization by cattle declines both due to a loss of palatable grass species and the physical barrier created by woody shrub species. To reverse woody species dominance, management practices such as roller-chopping and prescribed burning need to be employed. The objective of this study was to quantify the effect management practices had on utilization of native rangeland in South Florida by cattle. Changes in cattle use of a given rangeland site were inferred by changes in a distribution pattern of cows (*Bos* spp., n=4) that had been outfitted with GPS collars during November 2006 to March 2007. Cattle had access to areas of 179 acres that had not been chopped in the previous 20 yr as well as another area of 61 acres that was chopped in 2003. The area that was chopped in 2003 showed 50 to 200% greater utilization as determined by cattle position than those areas that had not been chopped in over 20 years.

0117

Efficient and Effective Methods for Monitoring Ecological Integrity on Grazed Lands

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Ecological integrity is the ability of an ecosystem to maintain stability and resilience when disturbed, retain native or natural components and processes, and remain sustainable without external inputs (Karr 1993). Our central hypothesis is that changes in ecological integrity may be anticipated through monitoring, allowing time to adapt management if needed to sustain ecological integrity. Because monitoring is a complex expensive task, our research objective was to develop methods and metrics that can be used by managers efficiently and effectively. We will collect data for five years (2006-2011) on grazed wildlife management areas (WMAs) in southeastern Washington State. The replicated study design includes two areas made up of six ecological sites distributed within nine pastures total. Methods and metrics are being developed from quantitative data (cover, frequency, and species richness), qualitative data (photo monitoring and rangeland health surveys), and desired ecological conditions based on state and transition models and classification systems previously published for the study area. Data will be mined to devise the most parsimonious metrics and create a model to allow managers to develop efficient and effective methods of monitoring ecological integrity.

0118

Use of Monitoring and Business Planning in the Context of Joint Cooperative Monitoring and Federal Grazing Allotments

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Federal grazing lands (BLM and Forest Service) are often critical components of western ranch operations. The interplay between management of the private ranch operations and the federal grazing allotments needs to be managed and considered in the context of the whole ranch operation. While management on federal lands often comes with significantly different objectives and management constraints, it is impossible to properly manage one part of the ranch operation exclusive of the other. The Forest Service and BLM continue to be involved in and supportive of the Sustainable Ranch Management process. A sound business plan that incorporates the special considerations associated with a federal grazing permit can help lead to improved communication between the grazing permittee and the agency. That communication is the foundation for a cooperative working relationship that can support sound and sustainable resource management. Management in this context often includes a strong emphasis on monitoring, use of that information in proposing management changes, and working closely with the agencies to adapt to changing conditions.

0119

Attitudes and Perceptions on Fire Policy and Burn Bans in Texas; A Working Model for Meeting Today's Complex Fire Management Challenges

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The Attitudes and Perceptions on Fire Policy and Burn Bans in Texas Survey was administered in Texas from October 2009-February 2010. The goal of the survey was to capture the qualitative thoughts, perceptions, and attitudes related to burn bans and prescribed fire in Texas. The survey was commissioned by the Grazing Lands Conservation Initiative. Texas A&M Institute of Renewable Natural Resources administered the survey. The survey was available online and was hand administered by Texas AgriLife Extension county agents, staff from NRCS, Texas Parks and Wildlife, and other interested partners. 412 respondents from 144 counties replied to the survey. Findings included information on implementation of burn bans, government code, granting of exceptions, and perceptions of prescribed burning. Outcome results of the survey were used to guide working groups in the state on areas of concentration for outreach, policy, and education. Currently, working groups are developing tasks and action plans to enhance the opportunities to understand, manage, and work together on rangeland resources in Texas.

0120

Sustainable Rangelands Roundtable (SRR) Overview

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The Sustainable Rangelands Roundtable (SRR) is an open, inclusive partnership process with a 10-year history of developing economic, ecological and social indicators for rangeland assessment at national, regional, and local ranch levels. The SRR also provides a forum for dialogue on rangeland sustainability and SRR participants envision a future in which rangelands are sustainably managed to provide a desired mix of social, economic, and ecological benefits. Participants include rangeland scientists and managers, ecologists, sociologists, economists, policy and legal experts, environmental advocates, and industry representatives. Past products include national indicators, an integrated concept for social, ecological and economic information, and an assessment framework for sustainable rangelands ecosystem goods and services. To help ranchers improve the quality of economic, ecological and social information available for ranch sustainability assessment, an SRR working group reviewed regional and national rangeland indicators to determine which elements should be monitored at the ranch level. Seventeen ranch-level indicators are categorized under the same five broad criteria for sustainable rangelands used at the national level. Assessment criteria include soil and water, plants and animals, productive capacities, social and economic benefits, and legal and institutional frameworks. Criteria are broad statements or categories that represent goals of sustainable development. Indicators are attributes that can be directly measured and assessed to detect changes and trends. The ranch sustainability assessment framework developed by the Sustainable Rangelands Roundtable emphasizes use of indicators designed to inform ranchers' business plans and track progress toward goals and objectives that embody the ranch family's values.

0121

Managing CRP Grasslands: Short- and Long-Term Effects of Haying on Breeding Bird Populations in CRP Grasslands in the Northern Great Plains

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The Conservation Reserve Program (CRP) is a voluntary program that is available to agricultural producers to help protect environmentally sensitive or highly erodible land. Management disturbances of CRP grasslands generally are not allowed unless authorized to provide relief to livestock producers during drought and other natural disasters, or to improve quality and performance of CRP cover. These disturbances may have short-term (1 year after disturbance) and long-term (2+ years after disturbance) effects on grassland bird populations. We assessed the effects of haying on 20 grassland bird species in 483 CRP grasslands in nine counties in four states in the Northern Great Plains between 1993 and 2008. We compared breeding bird densities in idled and hayed fields to evaluate changes one, two, three, and four years after haying. Haying of CRP grasslands had either positive or negative effects on grassland birds depending on the species, county, and number of years after the initial disturbance. Some species (e.g., Horned Lark, Bobolink) responded positively to haying, and others (e.g., Song Sparrow) responded negatively. The responses of some species changed directions as the fields recovered from haying. For example, densities for Sedge Wren and Clay-colored Sparrow declined the first year after haying but increased in the subsequent three years. Ten species showed Treatment x County interactions, indicating that the effects of haying varied geographically. This long-term evaluation on the effects of haying on breeding birds provides important information on the strength and direction of changes in bird populations following a disturbance.

0122

Food Habits and Diet Quality of Mule Deer Wintering on the North Kaibab Plateau of Arizona

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Increasing concern over the habitat quality and the desire to expand the population of mule deer (*Odocoileus hemionus*) on the north Kaibab winter range precipitated a three year study to determine the diet composition, forage quality and ability of the N. Kaibab habitat to support this population. Data on diet composition was determined using microhistological analysis of fecal material collected during three periods, late fall (late November) mid-winter, (January and February), and late winter (mid- to late March). Samples of all potential forage sources were collected from throughout the study area for analysis of crude protein, gross energy and dry matter digestibility. The dominant species were big sagebrush, cliffrose, apache plume, four-winged saltbush bottlebrush squirrel-tail, crested wheatgrass, and western wheatgrass. Habitat quality analysis found that the digestible protein intake of mule deer does was 2.6 times the daily requirement, while the metabolizable energy intake was as much as 450 Kcal/day below the requirements of a 55 kg doe carrying a single fawn, and as much as 625 Kcal/day below the requirements of the same doe carrying triplets. Intake of winter forage resources and available nutritional levels were linked to artificially low plasma metabolic indicators.

0123

Characterization of Forage Availability and Use by Feral Horses across Diverse Habitats in SW Alberta

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Feral horses have been present in Alberta since the early 1900's when unwanted workhorses were released into the wild. Recent increases in feral horse populations have led to questions regarding the availability of suitable habitat within the Upper Foothills and Subalpine Ecoregions. We characterized forage biomass and quality (crude protein), together with horse use (pellet counts), within 5 habitat types in the McLean Creek area during the summers of 2009 and 2010. During each year, 57 (2009) to 99 (2010) field plots situated across 2 primary (grassland meadows and adjacent shrubland) and 2 secondary (conifer forest and mixed forest) habitats, and 1 disturbed (conifer clear cut) habitat were sampled for herbage biomass at peak growth in late July. Samples were assessed for nitrogen concentration and converted to protein values. Preliminary results indicate that although shrublands and grasslands provide much of the available herbage in the region, clear cuts are an important source of herbage for feral horses across the landscape. These results are further supported by associated pellet count data. In contrast, forested habitats, particularly conifer areas, provide little opportunity for horse grazing due to low biomass availability. These results have implications for understanding feral horse habitat use patterns as well as potential multiple use conflicts with other land uses within this public land base.

0124

Habitat Selection by Free Ranging Feral Horses in the Alberta Foothills

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Since their initial release feral horses have been increasing in population size within the foothills of SW Alberta. These increases pose a potential concern to the ongoing conservation of native grasslands given their limited spatial availability and the presence of other land uses in the region, including cattle and wildlife grazing. Sustainable management of feral horses requires information on the inherent use of various habitats by feral horses. We utilized spatial data from 4 radio-collared mares to assess habitat use and preference from November of 2008 to November of 2010 within the McLean Creek area. Collars were programmed to collect geospatial information on the location of each horse every hour during this time and were remotely downloaded 4 times a year. Following geo-correction, spatial data were combined with habitat maps to assess feral horse preference or avoidance for different habitat types, including grassland, shrubland, conifer and mixedwood forest, and conifer clear cuts. Preliminary assessment using electivity indices (adjusted for availability) indicated that horses preferred grassland, shrubland and cutblock habitats during the winter of 2008-09, while avoiding uncut conifer forest and mixedwood forest. Additional analyses will be done using AIC models to examine feral horse behaviour, including their selection or avoidance of habitat features, such as topographic extremes (elevation and slope based on a DEM), distance to cover, and proximity to roads and primary recreational trails.

0125

Variation in Plasma Metabolic Indicators of Mule Deer Does on a Low Quality Winter Diet on the North Kaibab Plateau of Arizona

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As part of the overall effort to understand the nutritional status of mule deer does on the north Kaibab winter range, blood samples were collected in late fall from eleven to 16 hunter harvested does, and in late winter from 22 to 26 sharpshooter harvested does over three winters (November, 2005 to March 2008). Blood samples were screened for eleven separate metabolic indicators: plasma glucose, alkaline phosphatase, phosphate, plasma urea nitrogen, creatinine, plasma urea nitrogen:creatinine ratio, albumin, cholesterol, triglycerides, glycerol, and free fatty acids. These values were compared with dietary nutrient intake determined by microhistological analysis for diet composition and nutrient analysis of selected forage species for digestible protein, metabolizable energy, and dry matter digestibility. There was a minimal response to changes in diet quality for plasma glucose, alkaline phosphatase, and phosphate. Plasma urea nitrogen, creatinine and PUN:Creatinine ratio were higher in late winter than late fall. Changes in plasma triglyceride and cholesterol were insignificant between late fall and late winter. However, plasma albumin, free fatty acid, and glycerol were significantly higher in late winter than late fall reflecting the increased utilization of energy reserves due to prolonged intake of diets with metabolizable energy contents significantly below nutritional requirements. Digestible protein and metabolizable energy levels of forage resources were found to be data – point drivers of the plasma metabolic indices.

0126

Competition of Native Grasses from Invasion Transplanted into Russian Knapweed and Canada Thistle

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Invasive species negatively impact native recipient plant communities worldwide. Although individual native grasses can persist in areas dominated by invasive species, their ability to resist or reduce invasion is largely unknown. We assess the ability of alkali sacaton (*Sporobolus airoides* (Torr.) Torr.), a native grass, to grow and reproduce in the presence of two invasive perennials, Russian knapweed (*Acroptilon repens* [L.] DC.) and Canada thistle (*Cirsium arvense* [L.] Scop.). On two field sites (Crowheart, WY and Cheyenne, WY) and in an environmentally controlled lab (ESL), we compare growth of native grass. *S. airoides* differed in their community of origin (invaded plants formerly grown in invasions versus non-invaded plants which never competed with exotics). *S. airoides* from the two sub-populations were monitored for longest leaf, basal circumference, and tiller production with and without the presence of weeds. Invasive species recruitment, grass seedling germination, and establishment were also monitored. At Crowheart, when competing with *A. repens*, growth of plants (longest leaf, basal circumference, and tillers) of invaded grass was greater than growth of the non-invaded irrespective of sampling date. At Cheyenne, invaded plants competing with *C. arvense* grew larger (longest leaf, basal circumference, and tillers) than non-invaded grasses irrespective of sampling date. Flowering at Cheyenne was greater for invaded plants than non-invaded plants near the end of the study. Lines of native grasses collected from within historic invasions displaying strong competitive traits may be useful for reclamation at sites exposed to the risk of invasion.

0127

Contribution of Warm and Cool Season Grasses to Seasonal Herbage Availability in Loamy and Sandy Mixed Prairie Range Sites of Alberta

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Management of livestock in semi-arid regions requires an understanding of changes in seasonal forage availability and how these patterns differ across environmental conditions. Previous Mixed Prairie studies have indicated that warm season vegetation comprises a relatively small fraction of herbage on loamy soils, but that this contribution can increase in sandy soils, leading to greater herbage. We assessed standing biomass monthly from mid June through mid September of 2009 (inclusive) within each of 4 study sites, including two loam sites (*Stipa-Agropyron-Bouteloua* range type) and two sandy sites (*Calamovilfa* range type). We hypothesized that herbage would be greater within sandy areas due to greater warm season species and that total biomass would peak later in the year. At each site, biomass within five 0.25 m² plots was harvested to ground level at each interval, sorted to warm and cool season grasses, forb and litter components, dried and weighed. Our results revealed similar peak herbage on loamy (1554 kg/ha) and sandy (1439 kg/ha) sites. Peak grass biomass was in August for both locations, although temporal patterns of warm season grass growth differed between soils. In sandy areas, warm season grasses (mostly *Calamovilfa*) peaked in July (36% of grass biomass), while in loamy areas, grass biomass (largely *Bouteloua*) was sparse through July (<4%) but sharply increased in August (29% of grass biomass). These results suggest the contribution of warm season grasses to grazing in the northern Mixed Prairie of Alberta, including sandy soils, may not be as large as in other areas.

0128

Predicting Direct Fire-Induced Mortality of Four Prominent Rangeland Graminoids

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Post-fire grass mortality is difficult to predict. We used degree-seconds, heat duration, maximum temperature, and fuel load to predict and understand direct fire-induced grass mortality. *Bouteloua gracilis*, *Carex filifolia*, *Hesperostipa comata*, and *Pascopyrum smithii* were collected in the field and burned in a burn cage with native plant fuel loads of 500-9000 kg/ha, then placed in a greenhouse to observe regrowth and mortality. Degree-seconds, duration and maximum temperature were measured using thermocouples at the soil surface. Logistic regression was used to determine probabilities of plant mortality. All measures of heat increased with increasing fuel load. *Carex filifolia* and *Pascopyrum smithii* mortality were limited and not related to fuel loads or measures of heat. Logistic models correctly predicted mortality of *Bouteloua gracilis* 90% of the time using fuel load, degree-seconds, or heat duration. Maximum temperature correctly predicted mortality 74% of the time. All measures correctly predicted *Hesperostipa comata* mortality 82 to 85% of the time. Severe fire conditions were required to kill *Bouteloua gracilis* and *Hesperostipa comata*. Exceeding a 0.5 probability of mortality required fuel loads greater than 7500 kg/ha for *Bouteloua gracilis* and greater than 8500 kg/ha for *Hesperostipa comata*. All *Bouteloua gracilis* plants died with 9000 kg/ha fuel loads. Fuel load, degree-seconds, and duration were good predictors of plant mortality for both affected species. Maximum temperature was not a strong predictor for *Bouteloua gracilis* mortality. Fuel load was an easily measured predictor and could be used as a guide to predict grass mortality after fire.

0129

Development of a Fungal Seed Bank Pathogen for Cheatgrass Biocontrol on Intermountain Rangelands

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The fungal pathogen *Pyrenophora semeniperda* is abundant in cheatgrass (*Bromus tectorum*) seed banks on Intermountain rangelands. It often kills a large proportion of seeds that remain ungerminated after stand establishment each year, that is, the potential carryover seed bank. Our objective is to develop this naturally occurring organism as a mycoherbicide that can quantitatively remove the carryover seed bank. Such a mycoherbicide could then be used with conventional herbicides to eliminate established stands. This could provide essentially complete control of cheatgrass prior to restoration seeding. Field trials with provisional formulations, in cooperation with the Bureau of Land Management, the US Fish and Wildlife Service, and private partners, have demonstrated that this pathogen shows considerable promise for controlling cheatgrass and red brome (*B. rubens*). We have completed extensive research on genetic variation in this pathogen, and have documented variation in virulence that could potentially be exploited for greater biocontrol. In addition, we have examined impacts on seeds of nontarget hosts and ways of mitigating potential impacts. The current thrust of our research program is to develop delivery technology that will make this mycoherbicide commercially viable. This includes methods to stabilize virulence and viability in storage, and to improve carrier formulation to make the product more practical for field application. We hope to continue to improve our formulation, in cooperation with partners from public and private sectors, and to have a product to restoration practitioners within a few years.

0130

Effects of Changing Spatial and Thematic Scale for Mapping Greater Sage-Grouse Habitat

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Habitat maps and models are becoming increasingly important in conservation efforts at levels ranging from local to global. Maps vary in spatial and thematic resolution and matching these resolutions with conservation applications and management goals is essential. Conservation efforts in western Idaho include a local sage-grouse (*Centrocercus urophasianus*) planning area, West Central Plan, that has been set aside as part of a programmatic candidate conservation agreement with assurances (CCAA). In 2008, maps developed at 1:100,000 scale and containing only vegetation cover type data were found to be too coarse in thematic and spatial resolution to be useful in local planning. To improve these maps, we adjusted the thematic scale and tested the accuracy at two different spatial scales. Supported by field data, we created two shrub cover maps with four canopy cover classes via a supervised maximum-likelihood classification, one at a 3 meter pixel size and the other at 30 meter. Combining these shrub cover maps with vegetation based sage-grouse habitat models created by Gap Analysis Program, new habitat maps were created. We concluded that current maps could only predict habitat based on cover type and were not able to predict habitat for seasonal needs such as nesting and brood rearing, in which the sage-grouse prefers certain shrub cover levels. By adding shrub canopy cover, an additional degree of precision is available in determining habitat quality, thus improving the map suitability for local conservation efforts. Changes in spatial scale resulted in less significant changes to map utility.

0131

Estimating Influence of Stocking Regimes on Livestock Grazing Distributions

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Livestock often concentrate grazing in particular regions of landscapes while partly or wholly avoiding other regions. Dispersing livestock from heavily grazed regions is a central challenge in grazing land management. Position data gathered from GPS-collared livestock hold potential for increasing knowledge of factors driving livestock aggregation patterns, but advances in gathering the data have outpaced advancements in analyzing and learning from it. We fit a hierarchical seemingly unrelated regression (SUR) model to explore how season of stocking and the location where cattle entered a pasture influenced grazing distributions. Stocking alternated between summer on one side of the pasture one year and fall on another side of the pasture the next year for 18 years. Waypoints were recorded on cattle for 50 d each year. We focused our analysis on the pasture's 10 most heavily grazed 4-ha units, because these units were the most prone to negative grazing impacts. Though grazing of the study units was always disproportionately heavy, it was much heavier with the summer than fall stocking regime: Bayesian confidence intervals indicate summer grazing of study units was approximately double the average fall grazing value. This is our core result, and it illustrates the strong effect stocking season or date or both can have on grazing distributions. We fit three additional models to explore the relative importance of stocking season versus location. According to this analysis, stocking season played a role, but stocking location was the main driver. Ostensibly minor factors (e.g. stocking location) can greatly influence livestock distributions.

0132

An Assessment of Plant Community Structure, Herbivory, Soils, and State-and-Transition Theory on a Winterfat (*Krascheninnikovia lanata* [Pursh] A.D.J.Meeuse & Smit) Ecological Site

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State-and-transition models (STMs) have been successfully used to describe ecological dynamics in woodlands, shrublands, grasslands, and several other ecosystems. Changes in vegetation and soil are measured to gauge and predict plant community dynamics within ecological states and transitions between alternative ecological states. Ecological states and their boundaries are defined by a range of variability in vegetation and soil parameters. The ecological site classification system used in the United States requires the development of a unique STM model for each defined ecological site. The foundation of the ecological site concept is the estimation and quantification of a historical reference plant community. Historical information, land manager experience, and scientific data are used to quantify the historical reference plant community and gauge changes towards alternative stable states. In regards to winterfat plant communities and the Silty 6-10 PZ ecological site, conceptual STMs have not been fully developed or tested. The objective of this study was to develop, test, and refine a process-based, data supported, STM for the Silty 6-10 PZ ecological site. The predominant factor of disturbance on this ecological site for the last 100 years has been grazing by livestock. To develop the process-based STM for the ecological site, we conducted five-year grazing exclosure study and a piosphere study centered on a livestock watering point. Data from these studies supported the initial proposed STM for the ecological site. States defined were a Reference Winterfat State (State 1), Sickle Saltbush State (State 2), and a Creeping Wildrye State (State 3).

0133

Pyric Herbivory in Action on Boreal Rangelands? The Fire-Grazing Interaction of Wood Bison in Northeast British Columbia, Canada

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The Boreal forest is the most intact ecosystem in the world and it occupies half of the landbase in Canada. Boreal fire is important for its creation of shifting mosaics across the landscape which contribute to heterogeneity resulting in biodiversity and proper functioning ecosystems. Wood bison (*Bison bison athabasca*) were a keystone species of the Boreal with a historical grazing interaction with fire. Wood bison are a federally threatened and provincially red-listed species that were extirpated in British Columbia in the early 1900's. They were re-introduced in the late 1990's, however, they currently demonstrate a non-traditional resource selection: the right of way of the Alaska Highway. Therefore, we are studying the Wood bison behaviour in north east British Columbia, Canada. Our specific objectives are to determine how fire affects the grazing behaviour of the Nordquist Wood bison herd and to draw them away from the highway right of way through the use of prescribed fire and salting. We will use GPS collars and spatial analysis to demonstrate the amount of time the bison spend on and away from the Alaska Highway. We have established 5 exclosures with paired plots to capture the affects of grazing in a recent fire (Liard Fire084 in 2009). Preliminary observations suggest that the majority of time is spent on the highway and that Wood bison do not randomly use the Boreal. A landscape level analysis is needed in order to appropriately manage the herd and their habitat.

0134

Prairie Pothole Wetlands: Characteristics, Functions, and Values

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The Prairie Pothole Region (PPR) of the Northern Great Plains covers approximately 900,000 km² and extends from the north-central United States to south-central Canada. This region is distinguished by its high density of shallow depression wetlands, often referred to as potholes. Prairie potholes span a gradient of wetland types ranging from short-lived ephemeral sites to semipermanent basins that typically contain water throughout the year; they are most often classified according to their vegetation communities, water permanence, and relation to groundwater. Historically, the PPR was characterized by short-, mixed-, and tall-grass prairie interspersed with countless pothole wetlands. Today, the PPR consists primarily of agricultural lands, and estimates suggest that at least one-half of the original wetland area has been lost to, or modified by human activities. The PPR is widely recognized as a globally important region for waterfowl production, and a majority of North America's migratory birds and waterfowl rely on the Region's remaining wetlands for breeding and stopover habitat. Further, PPR wetlands have been attributed with providing numerous other ecosystem services, functions, and values such as floodwater attenuation, carbon sequestration, wildlife habitat, nutrient cycling, and groundwater recharge. Because of the recognized importance of PPR wetlands, many private and governmental organizations have placed high priority on restoring and protecting these critical habitats.

0135

Monitoring Plant Species Richness When it Won't Sit Still: Handling Temporal Variability in Vegetation Monitoring

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Maintaining biodiversity in rangelands requires systematic monitoring to acquire information about the status and trends of biodiversity in these areas. In Great Plains grasslands, plant species richness is a common measurement of biodiversity known to affect grassland productivity; however, researchers must consider the effects of high interannual variability in temperature and precipitation and have realistic expectations about the time necessary to detect a systematic trend. In published studies from this region, plot plant species richness often varied 20-40% among years, sometimes exceeding variation produced by experimental treatments or management actions. Using mixed-effects models and data collected in national parks of the northern Great Plains, we estimated a similarly high magnitude of temporal variability in species richness. We used the resulting estimates to compare the power of five alternative sampling designs to detect trends in plant species richness in northern Great Plains grasslands. All sampling designs required 8 to 30 years to detect moderate increases or decreases in species richness. Power to detect a trend was insensitive to moderate differences in the sample design as long as the schedule for visiting sites across time included annual temporal linkage among spatially disparate samples. Instead, power depended on the specified magnitude of temporal variability. This suggests that additional effort must go into understanding the causes of this temporal variability; relating fluctuations in species richness to fluctuations in weather is one potential means for explaining temporal variability and for increasing the power to detect trends.

0136

Multi-Scale Mechanisms and Effects of Fire Grazing Interactions

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Fire and grazing are two important disturbances affecting a large proportion of ecosystems. The ecological interactions between the two are critical and have a defining role across complex landscapes. Mechanisms of fire grazing interactions are largely associated with feedbacks through broad and fine scaled processes. We examined broad and fine scale mechanisms, specifically quantifying animal and fire behavior, vegetation quantity and quality, light environments, and plant morphology and physiology. Animal and fire behavior was largely influenced by the amount of time since fire (greater than all other predictors). Vegetation quality (crude protein) was highest in areas that were recently burned and grazed (ca. 18%) throughout the growing season and decreased in areas with greater time since fire (ca. 4%). Vegetation quantity was lowest in recently burned areas and increased with time since fire. High light environments were present in recently burned areas, and were maintained beyond the growing season. Total leaf area of *A. gerardii* was lowest in recently burned areas (ca. 8 cm²; maintained throughout the growing season) and increased with time since fire (ca. 80 cm²). In contrast, maximum photosynthesis of *A. gerardii* was highest in recently burned and grazed areas (ca. 50 μmol CO₂ m⁻² s⁻¹) and decreased with time since fire (ca. 20 μmol CO₂ m⁻² s⁻¹). Fire grazing interactions are complex ecological processes and play a significant role within the system, with a range of influence from animal behavior to plant physiology.

0137

Orthorectification, Mosaicking, and Analysis of Sub-Decimeter Resolution UAV Imagery for Rangeland Monitoring

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Unmanned aerial vehicles (UAVs) offer an attractive platform for acquiring imagery for rangeland monitoring. UAVs can be deployed quickly and repeatedly, and they can obtain sub-decimeter resolution imagery at lower image acquisition costs than with piloted aircraft. Low flying heights result in imagery highly suitable for mapping soil and vegetation types, structure, and pattern in great detail. Small UAVS are commonly equipped with lightweight digital cameras due to low payload capabilities, resulting in challenges associated with photogrammetric processing and creation of orthomosaics from large number of small footprint images. We developed a custom, semi-automated approach that is suitable for processing hundreds of UAV images into orthorectified image mosaics. A customized algorithm improves the accuracy of the UAV's exterior orientation data, comprised of position (X, Y, Z) and attitude (roll, pitch, heading) information. The corrected exterior orientation data are subsequently used as inputs for orthorectification and mosaicking with minimal or no need for tie- and/or ground control points, greatly reducing time and cost of processing. The workflow has been tested on 65 image mosaics (5-8 cm resolution) of arid rangelands with few distinguishing features. Orthomosaics created using this process have positional accuracies of 1 m in flat terrain and 1.9 m in hilly terrain. Object-based image analysis of the image mosaics has resulted in classification accuracies of 78%-92%, depending on vegetation type and number of classes. The results show that UAVs are viable remote sensing platforms and that quality products can be derived from the imagery.

0138

Genetic and Environmental Influences on Distribution Patterns of Beef Cattle Grazing Foothill Rangeland

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A study was conducted in foothill rangelands of Montana to evaluate the effects of genotype and environment (or early learning) on grazing distribution. Based on 5 years of observations, 5 of 180 cows that used the highest and steepest terrain (hill climbers) and 5 cows that used the most gentle terrain near water (bottom dwellers) were used as donor-dams for embryo transfer. A single AI sire was used in these matings. Recipient cows were classified as hill climbers (HC) and bottom dwellers (BD) based on 4 years of observation from a separate herd of 98 cows. This resulted in 2x2 factorial study with donor and recipient as factors and HC and BD as levels within each factor. During the summer of 2010, 24 of these cows (5 to 7 years of age) were observed by horseback observers during the early morning in a 336 ha pasture. Distance to water, elevation, slope and a normalized average of terrain attributes from recorded cow locations were evaluated using repeated measures analyses. Donor and recipient classifications and the interaction of donor x recipient classifications did not affect any measure of terrain use. However, biological mother within donor classification appeared to influence slope use ($P=0.09$) and the normalized average terrain use ($P=0.02$). Most cows used similar terrain as their biologic mother, but some mothers had daughters who used terrain differently. Grazing use of foothill rangeland appears to be affected to some degree by genetic factors, but the mechanism of this influence requires further study.

0139

Native and Shrub Tolerance to Aminopyralid (Milestone® Herbicide) Applications for Invasive Species Control

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Aminopyralid (Milestone®) is a broadleaf herbicide that has reduced risk to the environment compared with other herbicides, making it a desirable alternative for invasive weed control on wildland sites. Effect of aminopyralid on desirable forbs and shrubs is a consideration for land managers when making management decisions. Experiments were established at 10 locations in 4 states from 2004-2007 to determine long-term response of native forbs and shrubs to aminopyralid and to develop a tolerance/susceptibility ranking for native plants. Research locations were diverse plant communities with 29 plant families represented, with the greatest number of species (35%) in the Asteraceae family. Individual tolerance rankings to aminopyralid were established for 98 native forb species and 19 shrubs. Four ranking categories were developed: susceptible (S - 75% or more reduction), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT - 49 to 16% reduction) and tolerant (T - 15% or less). Of the 98 forb species categorized, 28, 17, 25, and 28 were ranked S, MS, MT, and T, respectively one year after application. Results from second year evaluations on 68 species showed most forbs had recovered with 77% of the species either MT or T. Shrubs were mostly tolerant to aminopyralid with 15 of the 19 shrubs ranked either MT or T after one year. Since most native forb and shrub species were moderately tolerant to tolerant, or quickly returned following treatment, land managers can use Milestone to restore the plant community by controlling invasive plants while minimizing non-target plant injury.

0140

Benefits of Fence Marking for Sage-Grouse

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We estimated greater sage-grouse fence collision rates in southern Idaho breeding areas and field tested the effectiveness of fence marking to reduce collision rates during spring, 2010. During fence collision surveys we located 50 avian collision sites, 36 of which were known sage-grouse. Estimated collision rates varied spatially between lek routes (0-1.428 known sage-grouse), and global collision rates were lower during the second round of sampling (0.099-0.356 known sage-grouse). Experimental fence marking studies were conducted using a complete block repeated measures design, with 8 different sites as the blocking variable and 5 sampling periods from March - May 2010. Pooling data over all sites and sampling rounds resulted in uncorrected collision rates approximately 5.74 times higher in unmarked control than marked treatment fence segments. The peak number of collisions occurred during late March and early April, with a decline for the remainder of the sampling periods. Future work will evaluate spatial and temporal variation in fence marking treatment effects. These analyses will be completed as part of a M.S. thesis in wildlife resources, and will be completed by May 2011.

0141

Pick the Low-Hanging Fruit First: Oregon's Strategy to Benefit Sage-Grouse by Removing Juniper

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The Oregon Sage-Grouse Habitat Improvement Initiative is designed to make significant progress toward reducing one of the primary, large-scale threats to sage-grouse in the state: juniper encroachment. Western juniper (*Juniperus occidentalis*) has increased the area it occupies ten-fold in the last 140 years, with the bulk of the expansion occurring in the sagebrush ecosystem. In Oregon, over 2.4 million acres of potentially suitable sage-grouse habitat is estimated to be currently affected by juniper expansion. As juniper invades, sagebrush declines and the plant community transitions to woodland that becomes increasingly unsuitable for sage-grouse. Fortunately, many areas are still in the early-to-mid stages of succession and have not yet lost key understory plant components making them relatively easy to restore for sage-grouse. Approximately, 800,000 acres of this potential habitat affected by juniper occurs within three miles of leks in Oregon. The Oregon Initiative focuses NRCS and partner resources on assisting landowners with removing juniper from these priority areas near leks with the goal of increasing the amount and quality of sage-grouse habitat. In 2010, \$2.6 million of Farm Bill program funds were obligated in contracts with 29 ranchers to remove juniper from 24,383 acres. A long-term research study is being set up with partners to study the effects of these treatments on sage-grouse productivity.

0142

NRCS Conservation Planning and Use of Monitoring and Business Planning Information

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The concept behind monitoring is to provide guide posts in decision making. Ranch monitoring is context dependent due to the highly contingent nature of the ecological, social and economic systems that a ranch may operate in. Each ranch will require its own unique monitoring plan. However, when monitoring is structured and meets some degree of standardization for comparative metrics, the effort can provide generalizations that are strong enough to make decisions on. The first phase of a conservation plan contains a resource inventory. This is the base of an ecological risk assessment and performance criteria for the sustainability of the ranch. The base will help place the ranch in context with the social and economic indicators that affect the ranch at their independent scales. We will describe: 1) the significance of ecological SRR indicators, 2) the scale, timing, and recurrence of standardized monitoring protocols, and 3) some of the tools available through NRCS.

0143

Working with Private Landowners to Recover Sage Grouse Habitat and Improve Ranching Sustainability in Nevada

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In Nevada, NRCS's goal is to improve working lands for the benefit of the greater sage-grouse, other sage-obligate species, and livestock. These benefits are being achieved through voluntary conservation and unique partnerships with other federal, state, and local agencies such as the Bureau of Land Management (BLM), Forest Service (FS), US Fish and Wildlife Service, Nevada Department of Wildlife, and Nevada Cattleman's Association. For the first year of the Sage-Grouse Initiative, interest was generated through a series of public meetings, news releases, and by word of mouth through other federal and state agencies. As a result, several contracts were funded to help restore, improve, and maintain greater sage-grouse habitat in Nevada. Projects include pinyon and juniper removal, marking problem fences, meadow restoration, prescribed grazing, seeding, and brush management. Due to the large amount of federal land ownership in Nevada it was necessary to engage the land management agencies in the NRCS planning process. For the 2011 Sage-Grouse Initiative, NRCS is continuing to develop and improve crucial partnerships with federal, state, and local agencies who share the goal to promote sage-grouse conservation. Through these partnerships NRCS is strategically focusing the Sage-Grouse Initiative funds on private and public working lands.

0144

Information Technology for Regional Collaboration in the Great Basin

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The foundation of any successful partnership is an efficient communication network. This may especially be true of natural resource-based collaborations where networks within science and management communities have unique needs. Communication among researchers, practitioners, policy-makers, and the general public requires efficiencies, sensitivities, and vocabularies that recognize the needs of each group. The team of data managers and science communicators at the USGS Forest and Rangeland Ecosystem Science Center (FRESC) has developed and maintained an information technology network to support effective regional-scale science and science application in the Great Basin for well over a decade. Some products, such as SAGEMAP (<http://sagemap.wr.usgs.gov>), are focused on providing consistent data sets for research coordination. Management-specific support is provided by tools such as the Sage Grouse Local Working Group Locator (<http://greatbasin.wr.usgs.gov/LWG/>). Additional, cross-cutting resources like the Great Basin Bibliography (http://www.nbii.gov/portal/server.pt/community/great_basin/561/great_basin_bibliography/1731) provide easy discovery of information for a broad audience of stakeholders. As a member of the Great Basin Research and Management Partnership (GBRMP), which promotes research, management and technology transfer, USGS has listened to the GBRMP leadership as well as a wide spectrum of regional stakeholders to identify, develop, and refine information tools needed to enhance broad-scale collaboration. Tools have been developed and are delivered on the GBRMP website (<http://greatbasin.wr.usgs.gov/GBRMP/index.html>). The website and its applications are built with a combination of HTML and .NET technologies and content is supplied by state, federal, and university collaborators. We realize that information development and delivery is a constantly evolving process and we consider any input valuable.

0145

Density of Crested Wheatgrass and Native Perennial Bunchgrasses 12-Years after Co-Planting

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Crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.) is an introduced perennial bunchgrass that has been successfully seeded in over 6 million ha in the United States and Canada. The competitive nature of crested wheatgrass may exclude and displace native vegetation from areas seeded to crested wheatgrass. A better understanding of the relationship between crested wheatgrass and native grass recruitment and survival is needed because crested wheatgrass is often seeded after wildfires to prevent exotic annual grass invasion. Crested wheatgrass is often selected for post-fire reseeding because it is easily established, is competitive for soil resources and can prevent exotic annual grass establishment, and is less expensive than native perennial bunchgrass seeding. To determine effects of co-planting crested wheatgrass with natives, we measured the densities of perennial bunchgrasses in plots that had specific densities of crested wheatgrass and seven native perennial bunchgrasses in 1998. We evaluated changes in the density of crested wheatgrass and native perennial bunchgrasses 12-years after co-planting. Crested wheatgrass density increased 40-fold and native grass densities either remained the same or decreased. The results of this study suggest that, when seeded together, crested wheatgrass recruits new individuals into the plant community, while native perennial bunchgrasses do not. The decrease in some native perennial bunchgrasses suggests that crested wheatgrass may be displacing native perennial bunchgrasses.

0146

Crested Wheatgrass Impedes the Spread of an Exotic Annual Grass

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Invasive plants are degrading wildlands around the globe by displacing native species, reducing biodiversity, and altering ecological functions. Preventing the spread of invasive species has been identified as an important strategy to protect wildlands. However, few prevention strategies have been tested. We hypothesized that establishing competitive vegetation next to infestations would increase the biotic resistance of the plant community to invasion and decrease the invasive species propagule pressure beyond the competitive vegetation. To evaluate this, we established twelve competitive vegetation barriers in front of invasive annual grass, medusahead (*Taeniatherum caput-medusae* (L.) Nevski) infestations. The nonnative perennial grass, crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) Schult), was seeded into plant communities adjacent to the infestations to create the competitive vegetation barriers. Soil nutrient concentrations and the spread of medusahead were compared between crested wheatgrass seeded and not seeded (control treatment) plots 3 years after treatment. Less medusahead and lower soil ammonium and potassium concentrations in the competitive vegetation barrier than control treatment suggest that establishing competitive vegetation increased the resistance of the plant communities to invasion. Medusahead cover and density in the plant communities protected by the competitive vegetation barrier (locales across the barriers from the infestations) were ~ 42- and 47-fold less, respectively, than unprotected plant communities. This suggests that invasive plant propagule pressure was decreased in the plant communities protected by competitive vegetation barriers. The establishment of competitive vegetation around infestations may be an effective strategy to prevent or at least reduce the spread of invasive plant species.

0147

Reducing Cholla Infestation in SE New Mexico, USA

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Cylindropuntia imbricata (walking stick cholla) can be a major pest plant on rangelands in the Southwestern US. Treatment options are limited by the expense of chemical control and the ability of cholla to resprout from stem fragments when treated mechanically. We studied the efficacy of mechanical control during the cool, non-growing season, when such treatment might be most successful. Treatments were applied after the first freeze, usually from November to March, by dragging three railroad irons, horizontally connected to each other by steel cables, behind a John Deere 4440 tractor. We selected pastures treated in 2006 (2 pastures), 2007 (3 pastures), and 2008 (4 pastures), as well as untreated areas (4 pastures), for comparison of treatment effects. Four sample points were established within each pasture, each consisting of three, 50mX4m belt transects arranged at random, but equidistant radial degrees around the central point. Data analysis showed that treated areas averaged 40-50 plants per ha, while untreated areas averaged over 350. Treated areas also had nearly 50% fewer cholla in the $<0.5\text{m}^2$ size class, indicating that resprouting of scattered stem segments was rare. No difference was observed between areas treated in different years, indicating that effects of this treatment method persist through time. Cholla can be a difficult rangeland pest to control due to constraints on money and time, but, by timing mechanical treatment of cholla-infested rangelands to coincide with the cool, non-growing season, good control may be achieved with little operating costs and substantial success.

0148

The Diversification of Crested Wheatgrass Experience

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In the Canadian prairies, the northern tip of the Northern Great Plains, there are over 1,000,000 acres of crested wheatgrass. A large portion was seeded in the 1930s to stabilize drifting soil. These seeded acres have received very few inputs and productivity has declined. In addition to seeded acres crested wheatgrass has invaded undisturbed native range. Work reported here was done to improve productivity of crested wheatgrass and to determine methods to replace crested wheatgrass with more desirable natives. Realizing the soil was prone to erosion if disturbed, techniques were examined which minimized soil disturbance. Comparison of burning, simulated grazing, suppression by herbicide, and control by herbicide found control was the only method that was effective. The grass species seeded into the sod also was dependant on location. In other work to increase productivity by introducing a legume found that a controlled vegetation strip of a minimum 50 cm was required. Comparison of seeders found that seeders which disturbed the covering of dead vegetation the least were more effective in establishing seedlings. Work is progressing to identify seeded plant communities which resist re-invasion of crested wheatgrass. At present, complete control of the crested wheatgrass works best with seeders which limit the amount of disturbance of dead vegetative cover. Selection of appropriate species for diversification of the crested wheatgrass stands is still being examined.

0149

Interaction between Morphological Development and Burning Effectiveness in Kentucky Bluegrass and Smooth Bromegrass

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Kentucky bluegrass (*Poa pratensis* L) and smooth bromegrass (*Bromus inermis* Leyss.) are two perennial cool-season invasive grasses in the northern Great Plains and fire may be used to manage them. Fire intensity is an important management issue in burning but less attention has been given to the morphological development of the target species when burned. A population based growth staging system (Nebraska System) was used to track the morphological development of Kentucky bluegrass (POPR) and smooth bromegrass (BRIN) prior to conducting weekly spring burns between the last week of April and the end of May in 2004 and 2005. Prior to burning, the Nebraska growth staging system was used to develop a morphological index (Mean stage by count, MSC) of POPR and BRIN. In late July or early August, 10 point frames were used to estimate relative species composition. Burning in late May in both years reduced the amount of POPR in the species composition by 15 to 20 percentage points compared to the unburned control. However, this same burning treatment increased the amount of BRIN by approximately the same amount when compared with early burns. POPR did not progress from the early vegetative stage (MSC = 1.1 to 1.2) during the monitoring period in either year. BRIN appeared to be most susceptible to fire at a MSC of 1.3 which is 1 to 2 leaf stage. Understanding the interaction between fire and morphological development can provide a tool for enhancing burning effectiveness.

0150

Applications to Current Monitoring Programs

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Summary comments with respect to current monitoring programs.

0151

Foraging for Rangeland Information in an Unfamiliar Virtual World

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The challenge is to find reliable resources that provide a benefit while avoiding resources that are harmful or have no benefit. Are we talking about a herbivore trying to forage in an unfamiliar environment, or a natural resource professional trying to find relevant information in the virtual world? Both! In this day of unlimited information, finding the most relevant and reliable scientific information can be a real challenge. New and improved ways to harvest and store information provide almost limitless resources to the inquiring range manager, however, it is easy to become bogged down in "information overload". Fortunately, there are several emerging websites, databases, and full text repositories designed specifically for range managers. This session will transcend from the information tools of the legends of range science and management to the modern information tools of today's range manager. It will begin with a historical tour of the digitized collection of Gus Hormay's carefully recorded observations and his contribution to the knowledge base of range science. The session will then introduce three newly developed and revised web based resources relevant to a broad array of range professionals, including students, land managers, and researchers. Additional presentations will reveal how to use these information tools to disseminate research findings to various audiences. The session will conclude with a panel discussion seeking input and design improvements from rangeland professionals.

0152

Collection of Very-High-Resolution Images from a Remotely Piloted Rotary Wing Vehicle: Applications in Utah Rangeland Monitoring

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Leptron Robotic Helicopters, Inc. has developed a Remotely Piloted Rotary Wing Vehicle (RPRWV) with fully automated piloting capabilities. The vehicle has been fitted with a 21 megapixel digital camera and a 300-mm lens, which makes it capable of collecting images with resolutions better than 1mm from a 33m altitude above ground. The Utah Department of Agriculture and Food (UDAF) has developed a method to collect vegetation survey data using the RPRWV photography to monitor the effects of rangeland treatments on a landscape scale. Due to the versatility and speed at which photographic data can be collected with the RPRWV, monitoring data can span multiple spatial and temporal scales compared with on-the-ground surveying methods. This paper describes the vehicle, its use and capabilities, comparisons with current UDAF sampling methods, and costs associated with its use to collect range sample sites.

0153

Stocking Rate Effects on Spatial Heterogeneity in Vegetation Cover in a Grazing-Resistant Grassland

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Spatial patterns in vegetation serve as indicators of rangeland condition and are an important component of wildlife habitat. We illustrate the use of very-large-scale aerial photography (VLSA) to quantify spatial patterns in bare soil of the northeastern Colorado shortgrass steppe. Using 3 pairs of pastures stocked at moderate versus very heavy rates, we detected higher bare soil under very heavy (22.5%) versus moderate stocking (13.5%; $P = 0.05$), while the coefficient of variation across pastures was lower under very heavy (0.48) versus moderate stocking (0.75; $P = .03$). Spatial autocorrelation was greatest at a 2-m separation distance under both stocking rates (Moran's $I = 0.48 - 0.58$). Bare soil still exhibited significant positive spatial autocorrelation across distances of 60 - 120 m under moderate stocking (Moran's $I = 0.14$), while patchiness at this scale was eliminated under very heavy grazing (Moran's $I = -0.05$). At scales of 120 - 480 m, we observed no spatial autocorrelation. Means and spatial patterns for bare soil were similar when analyses were restricted to a single dominant ecological site (Loamy Plains), indicating similar variation among versus within ecological sites. Thus, very heavy grazing did not increase bare soil patchiness at any of the scales examined. Our approach demonstrates the utility of VLSA for analyzing interactions between grazing pressure and other landscape features, and highlights the importance of georeferenced sampling across broad scales (pastures) while still testing for potential shifts in patchiness of bare soil at small (< 10 m) scales.

0154

Implications for Future Research

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Summary comments with respect to what the symposium presentations mean for future research.

0155

Community Responses to Climate Variability Over 50 Years in a Subalpine Rangeland

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Background/Questions/Methods: Proper rangeland management requires an understanding of factors influencing rangeland community dynamics; these factors include livestock management, climate variability, and temporal lags. Recently developed statistical methods can be used to mine historic data in order to determine the relative importance of different climate variables in explaining inter-annual vegetation dynamics. This work addresses two specific questions.

- 1) Which climate variables are most important for explaining the recruitment and survival of different subalpine species?
- 2) What are the species-specific responses to environmental pulses?

To address these questions we used a mixed linear model analysis with abundance as the response variable and combinations of temperature and precipitation parameters from spring, June, previous annual and previous summer as fixed explanatory variables and location and year as random variables. The analyses used historic data taken from chart quadrat drawings created by researchers at the Great Basin Experiment Station near Ephraim, Utah between 1913 and 1960. **Results/Conclusions:** Based on the analyses, it appears that species respond by varying degrees to environmental pulses that occur at different times of the year. *Vicia americana* showed a positive correlation with June precipitation, *Penstemon rydbergii* showed a possible positive correlation with previous annual and previous summer temperature, *Achillea millefolium* also showed a possible positive correlation with previous summer temperature, results also suggest strong correlations between average annual temperature for the previous year and abundance of *Agoseris glauca*, *Pseudostellaria jamesiana*, and *Viola praemorsa*. June temperature and precipitation show a positive correlation with the abundances of *P. jamesiana* and *V. americana*.

0156

Working with California and Nevada Ranchers in a Coordinated Effort to Recover the Sage Grouse

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In California, NRCS has been working cooperatively with our partners to address sage grouse resource concerns, while simultaneously improving rangelands to sustain private ranching operations. Partners and stakeholders for the sage grouse effort include, but are not limited to: local conservation districts, California Department of Fish and Game, Bureau of Land Management, US Forest Service, US Fish and Wildlife Service, University of California Extension, California Cattleman's Association, California Waterfowl Association, Intermountain West Joint Venture, Audubon, and local producers and landowners. Contracts with producers address identified sage grouse threats on private lands as well as allotments on public lands. Most projects involve juniper removal and several other structural modifications including attachment of fence markers, installation of cross fencing, fence removal, and other practices. The second significant effort is directed towards rehydrating upland meadows that have been degraded because of previous management practices. Installing grade stabilization structures, followed by planting of native vegetation in disturbed area is expected to significantly improve early and late brood rearing areas in the Modoc Plateau and Bi-State population management units. Addressing sage grouse resource concerns and rangeland resource concerns on private lands and the rancher's public allotment will enhance the recovery of targeted grouse populations as well as the sustainability of their ranching operations

0157

Field Test of Digital Photography Biomass Estimation Technique in Tallgrass Prairie

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Fuel loading information is important for prescribed fire planning and understanding fire effects in grassland. Yet, fuel loads in grasslands often go unmeasured because of the time required to clip plots and process samples, as well as limited access or proximity to a drying oven. We tested the digital photography biomass estimation technique (Limb et al. 2007) for measuring fuel load in grasslands in two national parks in the eastern Great Plains. The method consists of using percentage image obstruction, as determined by digital photography, to estimate vegetation biomass (i.e., regressing dry clipped weights against percent digital obstruction). We measured digital obstruction at two sites at Wilson's Creek National Battlefield, Missouri US (WICR) and three sites at Tallgrass Prairie National Preserve, Kansas US (TAPR). The method did not result in strong correlations at either of the two sites at WICR (site 1: $r^2 = 0.02$; site 2: $r^2 = 0.32$), but performed relatively well at TAPR (<1 yr since burn: $r^2 = 0.82$; 2 yr since burn: $r^2 = 0.57$; 1 yr since burn: $r^2 = 0.88$). Linear regressions for the three sites at TAPR did not differ in slope ($P > 0.05$). In general, the more dense the vegetation, the weaker the relationship between vegetation biomass of clip plots and the percentage image obstruction of digital images. The digital photography technique may not be useful for estimating fuel loads in grasslands with relatively high biomass (>80 g/0.1 m²), digital image obstruction >50%, or large amounts of litter.

0158

Artificial Selection as a Tool to Develop Native Plant Materials for Novel Ecosystems

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As far back as ancient times, artificial selection has been used as a tool to develop tolerance to biotic and abiotic stresses in crop plants. Its use became more formalized with the advent of plant breeding and later genetics as formal disciplines in the late 19th and early 20th centuries, respectively. As we proceed into the 21st century, the vegetation of our planet is faced with an onslaught of changes that may be new to its history, e.g., climate change, invasive species, new species assemblages, and soil modifications. These changes are catching the attention of plant ecologists, who are now referring to "novel ecosystems" and "domesticated nature." The question arises as to how to develop native plant materials that can function effectively in their emerging environments, which may function dramatically different from the environments of their own evolutionary past. Artificial selection, the human-mediated counterpart to natural selection, has promise for providing a partial solution to these problems, yet it is considered a "deal-breaker" by those who prefer native plant materials yet regard such genetically manipulated materials to no longer be native. This discussion will focus on how artificial selection can be applied to native-plant populations to enhance plant performance and improve ecosystem function.

0159

A Comparison of Vegetative Responses to Prescribed Fire in Grazed and Ungrazed Tobosagrass Flats in the Northern Chihuahuan Desert, Texas

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An understanding of different disturbance interactions and the rate at which herbaceous species diversity and cover may change is crucial to conserving desert grasslands. We tested the homogenous management model to a heterogeneity based model, using two different ignition patterns, and the effectiveness of each to increase vegetative biodiversity and cover in tobosagrass (*Pleuraphis mutica*) flats of desert grasslands. Prescribed fires were applied in a grazed (n = 1) and an ungrazed pasture (n = 2). Vegetation measurements were collected pre- and postfire. Sensors were placed in the burn units to ascertain fire behavior. Homogenous applications of fire resulted in a mean fire occurrence of $93.1\% \pm 3.4$ SE (n = 8) and $97.5\% \pm 0$ SE (n = 6) in the ungrazed and grazed pasture, respectively. The heterogeneous application of fire was implemented in an ungrazed pasture and mean fire occurrence ranged from 39.8% to 97.5% (mean = $75.1\% \pm 11.9$ SE, n = 5). Richness increased from 11 to 18 species in the grazed treatment, while the control decreased from 7 to 6 species. Seven months postfire, tobosagrass canopy cover in the grazed site is 42.4% ($18.1\% \pm 2.8$ SE) that of prefire conditions ($42.7\% \pm 5.8$ SE). The grazed control also experienced a decrease in tobosagrass cover. With this project we expect to start filling in the gaps of knowledge of fire behavior and fire effects of desert grasslands.

0160

Cottonwood Seedling Demography along the Upper Missouri River

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Within the Upper Missouri River Breaks National Monument (UMRBNM), concerns exist regarding the status and extent of cottonwood along the Wild and Scenic reach of the upper Missouri River. Declining, sparse, old trees with little recruitment of new individuals and the relative importance of controlling factors such as geomorphic setting, climate (ice), cattle grazing effects, and flow management from upstream dams are of importance to land and water managers within the basin. Bare, moist sites that are safe from subsequent disturbance are required for cottonwood recruitment. These requirements are most frequently met by flow-induced channel change. The reach of the upper Missouri from Coal Banks Landing through much of the UMRBNM is geologically young, exhibits low sinuosity, and is constrained within a narrow valley. Cottonwood amounts are sparse compared to wider valleys of the Missouri River where lateral channel movement created broad expanses of cottonwood forest. Results of this study confirm that new seedling establishment is strongly concentrated within the streamside zone which is bare and moist during seed dispersal. Seedling survivalship into following years is highest above subsequent high water stages but decreases at the highest locations. Safe establishment sites may be met by floods which initially establish seedlings on high and safe surfaces and subsequent vertical accretion which moves sites higher and safer. Seedling survivalship declines with increases in grazing intensity, and seedling to sapling recruitment rates are very low and can be completely blocked by intense grazing.

0161

BLM New Mexico: Fostering Successful Partnerships to Restore New Mexico's Enchanting Landscapes

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Restore New Mexico is an aggressive partnership launched in 2005 to restore native grasslands, woodlands, riparian areas, watersheds, and wildlife habitat to a healthy and productive condition. Since its inception, more than one million acres of degraded landscapes have been treated to restore those landscapes to a healthy ecological state. BLM New Mexico has been successful in its restoration effort largely due to strong partnerships between the BLM and grazing permittees, conservation groups, the oil and gas industry, the New Mexico Association of Conservation Districts (NMACD), major universities, research institutions, county governments, and a variety of State and Federal agencies (New Mexico State Land Office (NMSLO), New Mexico Department of Game and Fish (NMDGF), Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA)). Besides treating hundreds of thousands of acres per year, the BLM is actively working to monitor the vegetative, biological, and hydrological responses to the treatments completed with Restore New Mexico. BLM-NM has enlisted assistance from New Mexico State University, USDA-Agricultural Research Service, NMDGF and several other entities to design and implement monitoring studies. These monitoring efforts have been a team effort within and outside the organization. Results from the monitoring efforts of BLM-NM are not solely for the benefit of the BLM; they are shared with universities and research organizations to benefit all of the partners of Restore NM.

0162

Selling Conservation to Get Producer Buy-In

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We were able to promote Sage Grouse Conservation by developing a plan that was based on mutual gain by developing a relationship base on trust and respect. To do this we worked with area rancher outside of the standard programs and assisted with day to day ranch activities when the opportunity arose. We are able to share our experience of working on multiple ranches in multiple states to show what worked and what did not work. Our focus was on identifying all resource concerns and developing alternative PRIOR to any discussion about program activities or cost share. By giving these ranches an UN-biased inventory of their operation and making suggestions on things they might consider to improve their bottom-line, they in turn were willing to listen to how these changes were going to improve sage grouse habitat. Of the ranches inventoried all but two took ownership of the plan and agreed to participate in the special initiative. There are now additional ranches located in the core area that are interested in participating and are currently inventoried.

0163

Healthy Rangeland Watersheds and Productive Livestock Enterprises: Why Not?

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The public expects range management to provision ecosystem services such as clean water, runoff and nutrient retention, and diverse riparian habitats. As a result, manager paradigms have dramatically shifted from a predominant emphasis on production to a balance of conservation and production goals. For example, practices including upland vegetation conversion to enhance water yield and forage production have been refocused toward restoration of hydrologic function and landscape heterogeneity outcomes. Moreover, riparian areas were once sacrificed to maximize livestock production, but now grazing is often curtailed to conserve riparian dependent species. Several decades of management and research show that opportunities abound to enhance rangeland watershed health. However, these opportunities often come with livestock production tradeoffs. Stocking rate reductions and livestock movement through herding or rotational grazing, in conjunction with fencing and drinking water developments, are commonly required to achieve riparian area use targets and reduce fecal microbial pollutant transport during runoff events. The cumulative enterprise costs of applying these practices are not well documented. Continued progress toward healthy watersheds and ranching enterprises will require integrated and adaptive management and research activities. Progress will also require the public to acknowledge the costs of managing for multiple ecosystem services and the limited capacity of ranching enterprises to financially support these public goals, which are by and large non-revenue generating.

0164

Using the Sage-Grouse Initiative, Conservation Easements, and State Regulations to Address Threats to Sage-Grouse Habitat in Wyoming

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Habitat fragmentation is widely believed to be the largest threat to sage-grouse in Wyoming. The State of Wyoming has actively supported the maintenance and enhancement of sage-grouse habitat in designated Core Population Areas through its regulatory and habitat programs. Such support has facilitated the use of the NRCS Sage-Grouse Initiative (SGI), Farm and Ranch Land Protection Program (FRPP), and Grassland Reserve Program (GRP). NRCS is targeting its resources to the Wyoming Core Areas and is addressing habitat fragmentation in two significant ways. First, use the SGI to help keep private ranches profitable and sustainable by implementing technically sound grazing plans that incorporate sage-grouse and livestock needs. The SGI in Wyoming is focused on helping ranchers manage grazing lands to improve nesting and brood-rearing habitat in or near Core Population Areas. Resource inventory, grazing plans, and habitat and grazing monitoring are key components on the 117,151 acres funded through SGI in 2010. Second, through conservation easements, purchase development rights from willing ranchers. These easements can keep working lands that are currently providing valuable habitat, working. Wyoming NRCS and its land trust partners have established more than 85,000 acres of Conservation Easements within Core Areas.

0165

Expediting State-and-Transition Models through Sorting of Ecological Sites into Disturbance Response Groups

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Ecological Site Descriptions (ESD) synthesize information concerning soils, hydrology, ecology, and management into a user friendly document. A crucial component of an ESD is the state-and- transition model (STM) that identifies the different vegetation states, describes the disturbances that caused vegetation change, and the restoration activities needed to restore plant communities. The Natural Resource Conservation Service estimates there are approximately 18000 ecological sites in the U.S. To expedite development of STMs, we propose a process of grouping ESDs in each Major Land Resource Area (MLRA) into disturbance response groups. An expert team of range and soil scientists follow a multi-step approach to response group development: (1) review MLRA characteristics, (2) establish guidelines for STM development, (3) sort ESDs into dominant cover type groups, (4) sub-divide cover type groups by climate, production and soil properties, (5) evaluate response to disturbances, and (6) define the soil-site concept for each group and select a modal ecological site. A draft STM is developed for the modal site prior to field investigation. GIS is used to guide field visits, verify soil map units, ecological sites and fire history. Soil scientists verify soil components, range professionals document vegetation and rangeland health and the team determines the current state and refines the draft model as necessary. Multiple locations for each modal ESD are visited in order to document alternate stable states. Non-modal sites are also visited in order to describe differences in resilience from the modal ecological site. An example from MLRA 24-Nevada will be presented.

0166

Capabilities, Challenges, and Cost of Using Unmanned Aerial Vehicles for Natural Resources Monitoring

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Unmanned aerial vehicles (UAVs) have been utilized recently to obtain very high resolution (about 5 cm) images for use in natural resources monitoring because of their capability to fly at low altitude. Many small UAVs (<50 kg) are available for purchase and this category is most likely to be used for natural resources applications in the immediate future. One needs to thoroughly weigh UAV specifications versus the objectives of the planned monitoring work before purchase. Most current UAVs have at least a video camera and a small consumer grade digital camera. We have found that for rangeland monitoring, the digital camera is the most useful. Once the UAV system has been acquired, the major challenge is to learn the regulations for flying in the FAA National Airspace System or in restricted military airspace. The limiting factor at the moment is to learn how to fly effectively abiding by the line-of-sight restrictions in effect today. The Jornada UAV team has developed a method for flying either in FAA or restricted airspace, and has acquired about 15,000 images over western U.S. rangelands. Our current UAV system including airplane, catapult launcher, and ground control station costs less than \$50,000. We are currently replacing the video camera with a multispectral camera which costs \$15,000. The data we obtain is extremely useful in determining rangeland health and can also be applied to watershed modeling and archeological studies.

0167

Government Success in Partnerships: The USDA-ARS Area-Wide Ecologically-Based Invasive Annual Grass Management Program

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As new research is conducted and new methods for solving problems are developed, the USDA-ARS has a program that allocates substantial funding to ensure these improved strategies and techniques are adopted by those who can benefit from them. These programs are called Area-wide demonstrations. A partnership of researchers, educators and ranchers have been implementing an area-wide project over the past 3 years to catalyze the adoption of ecologically-based invasive annual grass management across the western US. The program includes establishing watershed-scale demonstrations of improved strategies, conducting critical gap-filling research, and a comprehensive outreach program linked to the demonstrations. Landscape-scale demonstration areas have been implemented with producers in Utah, Idaho, Oregon, Nevada and California. Additional research projects are filling in information gaps, with work ongoing on site history, economics, weather and climate forecasting, and seedling establishment. An integral component of the project is an education and outreach program. To advance the use of ecologically-based management, we created an entire decision-making process that guides land managers through a series of assessments and decisions which lead to an entire invasive plant management plan. This iterative, hands-on process uses state-of-the-art assessment with ecological principles that allows managers to address the underlying causes of invasion to create sustainable plant community trajectories. Managers from most western states are beginning to use the decision-making framework.

0168

Comparing Grazed Allotments in Arizona on Their Ability to Convert Precipitation to Vegetation

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Public land managers find it is costly and difficult to develop a synoptic understanding of spatial and temporal trends on rangeland. We describe a preliminary effort to provide such an understanding in Arizona based on remotely sensed data. We created a merged GIS layer using publicly available data for grazed allotments, primarily from the Arizona State Land Department, Forest Service, and Bureau of Land Management. PRISM annual precipitation estimates at 800 m resolution were aggregated for the almost 2100 grazed allotments and averaged for the 9 most recent available years (2000-2008). Measurements of green and senescent vegetation foliar cover were fit to 30 m Landsat derived Soil Adjusted Total Vegetation Index (SATVI) observations, and these Landsat cover estimates were scaled to 500 m MODIS observations to create estimates of total vegetation cover every 8 days from early 2000 through 2009. A linear regression of the 10 year average cover on the 9 years of average precipitation for all allotments explained more than 70 percent of the variability in cover, though a loess relationship fit the data better at the ends of the precipitation range. By subtracting the expected cover based on the PRISM precipitation from the MODIS estimated cover, the impacts of factors other than precipitation, including management, were highlighted. Using this approach, public land management agencies in Arizona can start to develop a synoptic understanding of spatial and temporal trends in the land they manage, identify the scope for management to increase cover, and complement field vegetation monitoring.

0169

Comparing the SamplePoint and Point Intercept Monitoring Methods

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In June 2007, fifteen professional range managers ran an identical trend transect on a sandy ecological site in the 7-9 inch precipitation zone using two methods. The SamplePoint method is an image-based system that provides for computerized analysis of photographs to yield frequency and cover data. The Point Intercept Method is a favored traditional method to collect similar data. The objective was to evaluate repeatability among users. Repeatability was similar, but - excluding transportation time, which is the same for both methods - the SamplePoint Data took only half as long to collect and analyze. SamplePoint offers distinct advantages linked to photos providing a permanent record. SamplePoint analysis can be re-conducted if error is suspected from the two key sources of trend data error: 1) divergent ground rules and, 2) misidentification of plant species. The SamplePoint method also offers the opportunity to reread the photos by different criteria if objectives change. The SamplePoint method has two weaknesses: 1) only the top layer of the canopy can be recorded, and 2) the ground-based transect method used in the study is only effective in low growing vegetation where a photographer can take nadir angle photographs of the plots. However the study detected significant variation in multi-canopy data using the Point Intercept Method. The SamplePoint method is an attractive alternative in Wyoming and mountain sagebrush, shortgrass prairie, and salt desert vegetation types.

0170

Effects of Off-Road Vehicles on Rodents in Sonoran Desert Rangelands

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Human recreation on rangelands may negatively impact wildlife populations. Among those activities, off-road vehicle (ORV) recreation carries the potential for broad ecological consequences. A study was undertaken to assess the impacts of ORV on rodents in Arizona Uplands Sonoran Desert. Rodents were trapped at 5 ORV and 5 non-ORV sites in Tonto National Forest, AZ. We hypothesized that rodent abundance and species richness are negatively affected by ORV use. Rodent abundances were estimated using capture-mark-recapture methodology. ORV use was not correlated with overall rodent abundance or with species richness. While abundance of *Peromyscus eremicus* declined with ORV use, abundance of *Dipodomys merriami* increased. Abundance of *Neotoma albigula* and *Chaetodipus baileyi* were not correlated with ORV use. Other factors measured were percent ground cover and percent shrub cover. Overall rodent abundance increased with shrub cover and with ground cover, but no significant correlation exists between these factors and abundance of any single rodent species. Shrub and ground cover both decreased as ORV use increased.

0171

***Pinus ponderosa*: An Examination into its Past, Present, and Future Suitable Habitat in Arizona**

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Ponderosa pine is currently the third most abundant tree species in Arizona based on Forest Inventory and Analysis (FIA) records. We explore the past, present, and potential future suitable habitat of *Pinus ponderosa* throughout Arizona to investigate possible range shifts during the past and next 100 years. Details from Merriam (1895) were used to determine a potential historical range for the San Francisco peak region, and a current distribution was generated from FIA data. Potential suitable habitat into the future was simulated using the DISTRIB model (Prasad et al. 2006) and 35 predictor variables. Three GCMs (HadleyCM3, PCM, and GFDL-CM2.1) and two CO₂ emission scenarios (A2 (high), and B1 (low)) were used to explore the potential effects of different climate effects on Ponderosa Pine distribution.

0172

Change on the Range: Ten Years of Rangeland Monitoring on the Tonto National Forest

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A collaborative rangeland monitoring program, Reading the Range, was initiated on the Tonto National Forest in 2001. 39 grazing allotments are now enrolled in the program encompassing 398,771 ha. Vegetation and climate have varied markedly since project inception. In 2002, a drought occurred, equaled in severity only by the years 1904, 1773, 1685, 1664, and 1150 AD. Mid-elevation (1,219 to 1,676 m) monitoring sites have demonstrated considerable variation in vegetation attributes, including forage production. Two locations exemplify this variability; one where a grazed site was compared to an isolated butte on a similar ecological site which had never been grazed, and the other recording a surprising response to grazing management. In the grazed versus ungrazed comparison, 2001 monitoring showed perennial grass comprised 57% and 42% of the botanical composition by weight on the the grazed and ungrazed sites. In 2003, after the extreme 2002 drought, the perennial grass composition was 19% vs. 2% respectively, and in 2009, 55% vs 12%. In the other case, a cross fence was installed in 2001 to control concentrated livestock grazing. Before the cross fence installation, perennial grass composition by weight was 8%, but by 2009 had increased to 40%. Given the dynamic nature of vegetation responses to climate in the mid-elevation zone of the Tonto National Forest, it is imperative that adaptive management be practiced.

0173

Effects of Climate/Vegetation and Level of Herbivory on Soil Carbon and Nitrogen in Semi-Arid Rangelands

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We examined the effects of climate/vegetation and herbivory upon soil carbon and nitrogen in semi-arid central Arizona rangelands. Soil samples within 2 climate/vegetation types (desert shrub:DS, piñon-juniper:PJ) and 2 grazing histories (moderate-heavy:HG, none-light:LG) were collected under shrub canopy, grass canopy, and within interspaces in winter 2009 and spring 2010. Ground cover was obtained on 3 transects within each treatment. Treatment differences were determined by analysis of variance. Percent bare soil was higher ($P < 0.1$) in HG (29.3 ± 3.7) than LG (21.2 ± 1.7). Percent litter was greater ($P < 0.01$) in PJ (50.2 ± 2.4) than DS (27.2 ± 2.3). Percent carbon and nitrogen were greater ($P < 0.01$) for shrub (3.39 ± 0.26 ; 0.24 ± 0.02 respectively) than for grass (2.19 ± 0.11 ; 0.16 ± 0.01 respectively) or interspace soils (1.59 ± 0.15 ; 0.11 ± 0.01 respectively). PJ had greater percent ($P < 0.05$) nitrogen (0.19 ± 0.01) than DS (0.14 ± 0.01) and had numerically higher percent carbon (2.55 ± 0.18 ; 2.22 ± 0.15 respectively). HG had greater ($P < 0.05$) percent carbon (2.68 ± 0.17) than LG (2.09 ± 0.16) but was similar for percent nitrogen ($\sim 0.18 \pm 0.01$). There was a grazing by position interaction ($P < 0.05$) for percent carbon in that under plant canopies, HG (3.28 ± 0.26) $>$ LG (2.30 ± 0.23), while within interspaces LG (1.68 ± 0.27) $>$ HG (1.49 ± 0.14). The effects of herbivory on soil nutrient characteristics should be evaluated within the context of site and climate.

0174

Selecting for Cattle That Enhance Biodiversity in the Sagebrush Steppe

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It is widely recognized that historic and repetitious spring grazing by livestock in combination with altered fire regimes has led to increased density and abundance of big sagebrush and a corresponding reduction in the frequency of perennial grasses and forbs on many western landscapes. Applying disturbance ecology mechanisms in order to promote resilience can be accomplished with livestock by making wise use of the resources that are in a given landscape in order to promote the best human and animal outcomes while reducing our dependence on limited, foreign, and cost prohibitive energy resources. Cattle can learn to eat sagebrush during fall and winter when big sagebrush chemistry becomes favorable (Kelsey, et. al., 1982) and when perennial herbs are dormant. We have documented that cow/calf pairs strategically supplemented with protein and energy, to mitigate the effects of residual terpenes and other secondary compounds in big sagebrush, will select big sagebrush as a significant portion of their diet. This biological approach to habitat renovation can be an alternative to landscape manipulations with chemicals, mechanical treatments, and fire, all increasingly impractical due to environmental concerns, the high costs of fossil fuels and the need to repeat the treatments that generally employ an outcome based, rather than a process based, strategy. Selecting for locally adapted cattle that are behaviorally, physiologically, morphologically, and genetically suited as disturbance surrogate vectors will serve to make this biological approach to sagebrush steppe resiliency treatments a reality.

0175

Growth Dynamics of *Hesperostipa comata* and *Pascopyrum smithii* in Alberta Dry Mixedgrass Prairie

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Maintaining rapid and continuous growth in grasses under rotational grazing is assumed to increase forage productivity. Limited evidence corroborating this in arid and semiarid rangelands, however, suggests that grasses in these environments may have determinate growth characteristics. Specifically, we hypothesized that (1) determinate growth is more characteristic of caespitose grasses because they predominate under increasing aridity; and that (2) increased resource (e.g., moisture) availability promotes continuous growth in rhizomatous grasses. To test this we assessed growth dynamics of respective caespitose and rhizomatous grasses, *Hesperostipa comata* and *Pascopyrum smithii*, under a factorial treatment combination of four defoliation and two moisture regimes (ambient rainfall and >200% of spring precipitation) applied to plots within 2 late seral dry mixedgrass communities in Alberta, Canada during summer 2010. We modelled aboveground biomass accumulation and quantified herbage removal as well as tracked tiller demography. Preliminary results revealed that early spring growth was rapid (even without moisture addition) and high intensity defoliation at this time may have enhanced relative growth rates for both grasses. While subsequent regrowth remained highly dependent on moisture, growth rates declined through the growing season, with *H. comata* producing more relative growth regardless of moisture regime. As well, tiller longevity was greater in *H. comata* under defoliation while tiller turnover was markedly greater in *P. smithii*, especially under ambient rainfall. Our results suggest that (1) the caespitose growth form confers greater genet fitness and growth potential in semiarid grasslands and (2) defoliation does not promote consistent regrowth throughout the growing season.

0176

Monitoring Shrub Canopy Cover Using Vegetation Charting Technique

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Plant cover is one of the most frequently used measurements for vegetation monitoring of rangelands. In this study, we explored the utility of Digital Vegetation Charting (DVC) for monitoring shrub canopy cover. The experiment was conducted under field conditions in Northwestern Syria, where seedlings of seven shrub species (*Atriplex leucoclada*, *Atriplex halimus*, *Atriplex lentiformis*, *Atriplex canescens*, *Atriplex nummularia*, *Salsola vermiculata* and *Haloxylon aphyllum*) were monitored for one year. The experimental layout consisted of a randomized complete block design with five replications. Straight down images for each plant were acquired at a fixed height using a high-resolution digital camera on three dates over time. On the last date, aboveground shrub biomass was clipped to estimate the dry matter weight per species. In this study, an estimate of greenness (percent green vegetation cover) was extracted by way of mathematic algorithms from the photo time series using VegMeasure 2 software. We found that cover of the seven species differed ($<.001$). *A. leucoclada* had the highest vegetation cover (56%), while *H. aphyllum* had the lowest figure (7%). With the exception of *H. aphyllum*, we found strong positive correlation between vegetation cover and biomass (DM) ranging from 0.86 to 0.93. This method provides a reasonable estimation of canopy coverage and can indicate aboveground phytomass. We conclude that DVC offers a rapid, reliable, and consistent measurement of shrub cover as long as shrubs have an open architecture.

0177

Evaluation of Habitat Use by Sharp-Tailed Grouse on the Grand River National Grasslands in Northwest South Dakota

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Sharp-tailed grouse (*Tympanuchus phasianellus*; STG) utilize a mosaic of grassland resources from warm and cool season grasses to shrub and riparian areas. For STG the height and density of cover maybe directly related to several aspects that affect reproduction and recruitment; including nest success, and hen and chick survival. The utilization of rangeland by livestock has varying effects on height and density of the vegetation; therefore, likely may have some indirect effects on STG populations. Livestock grazing is the dominant management tool used by the United States Forest Service (USFS) on public lands throughout most of our study area. The STG is used as an indicator species in North and South Dakota by the USFS and plays a significant role in how stocking rates are determined. We used radio telemetry to investigate the reproductive success and habitat selection characteristics of STG on the Grand River National Grasslands in South Dakota during the spring and summer months of 2009 and 2010. We monitored 22 and 24 nests with a Mayfield nesting success rate of 25% and 28% in 2009 and 2010; respectively. The average visual obstruction reading (VOR) at nest sites was 10.2 ± 1.3 cm, while the average VOR at randomly selected sites 5.6 ± 0.5 cm in 2009. In comparison, in 2010 the average VOR at nest sites 15.7 ± 0.8 cm while the average VOR at randomly selected sites 13.5 ± 1.0 cm. Our data suggests that on average STG selected areas with higher levels of visual obstruction for nest sites compared to the surrounding area.

0178

Grazingland and Economic Sustainability: The Balancing Act

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Today's rancher is faced with numerous challenges just to stay in business. If economic sustainability of the ranch is challenged, often the grazingland resource suffers. In 2007 the rancher led Blackland Prairie Grazing Lands Conservation Initiative Coalition decided to mount a regional effort to promote grazingland stewardship and education through workshops and onsite technical assistance to landowners in the Blackland Prairie MLRA. Their recent focus has been to demonstrate to landowners the management practices that have positive ecological and economical benefits. The Coalition then developed a four part series of workshops based on that premise. The first was a Ranch Economics conference designed to illustrate the economic benefits of basic management practices. The second was a Stockmanship clinic that focused on low stress cattle handling techniques and illustrated the economic benefits on herd health and disposition. The third was a Ranch Diversification workshop that outlined successful methods of vertical ranch integration by making more income on the same acres. The final workshop was a focus on Ranch Production to Profit, focusing on limiting non-profitable inputs thereby increasing ranch profits. Over the past two years, more than 450 ranchers have participated in this workshop series. They have been implementing many of the practices they have learned and are reporting success. The successes can be attributed to the improvement of the rancher's economic situation, natural resources, and self-confidence. The Blackland Prairie GLCI coalition is well on its way to effecting positive ecologic and economic change in the region.

0179

Managing Rangelands for Multiple Ecosystem Services: Opportunities and Tradeoffs

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Many rangelands have been traditionally managed principally for livestock production through the use of sustainable stocking rates that optimize livestock weight gains on both a per head basis and a per unit land area basis. Contemporary management of rangelands, however, emphasizes enhancing multiple ecosystem services from these lands. As such, there will be opportunities available to rangeland managers in the US and Canada to capitalize on these ecosystem services through emergent markets as well as tradeoffs associated with changing management from the traditional approaches emphasizing livestock production to managing for multiple ecosystem services. This symposium provides a series of interrelated presentations addressing the opportunities and tradeoffs associated with managing Canadian and US rangelands for greenhouse gases, water, plant diversity and wildlife habitat, as well as livestock production.

0180

Plant Materials Development for Disturbed Southwestern Landscapes

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The service areas of the Los Lunas Plant Materials Center are primarily located in the arid and semiarid ecoregions. These regions receive less than 13 inches of annual precipitation making it extremely challenging to establish field plantings using traditional methods. Established in 1934, the Plant Materials Center and its partners have been developing effective planting strategies for the arid Southwest. These planting strategies include some type of moisture enhancement treatments which are necessary for successful establishment in arid environments. Treatments include mulches, hydrophilic polymers, deep-rooted systems, the deep-planting methods of longstems and pole cuttings into shallow groundwater, proper timing of plantings, and the use of local populations. Case studies will be presented that will include photos of sites with before and after examples of plantings.

0181

Biological Assessment and Monitoring of Wetlands in the Prairie Pothole Region

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The Prairie Pothole Region (PPR) is one of the most wetland rich areas in the world. Wetlands in the PPR are diverse in plant and animal life, function, stressors, and management. This diversity leads to challenges both in how to monitor and assess wetlands, as well as how to work with landowners and managers. A common method of assessment used across the United States is the three tiered wetland assessment design. This design includes: 1) a landscape level assessment - Level 1; 2) a rapid assessment - Level 2; and 3) an intense assessment - Level 3. Specific methods within this three tiered design have been created for the PPR and North Dakota including: 1) Level 1 - geographic information system-based Landscape Wetland Condition Analysis Model (LWCAM); 2) Level 2 - North Dakota Rapid Assessment Method (NDRAM); 3) Level 3 - vegetative-based Index of Plant Community Integrity (IPCI); and 4) the Hydrogeomorphic (HGM) model. This design is also being used as part of the Environmental Protection Agency's 2011 National Wetland Condition Survey. Other assessments are used based on agency and landowner needs for monitoring and assessing wetlands. Information from our research can be used to make decisions about need specific, financial, and time appropriate wetland sampling methods. Also, this information will help to inform wetland managers about the types of methods and assessments that may be available, as well as to some of the frustrations and concerns that go along with assessment and monitoring.

0182

The Role of Fire in Sustainable Rangeland Ecosystems

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Rangeland ecosystems evolved with relatively frequent fire and thus the biotic ecosystem components are well adapted and often dependent on fire as a driver of ecosystem function. Fire was as integral to these landscapes as soil type, climate and herbivory. Following European settlement, fire was removed from much of the global landscape often altering key ecosystem properties. A number of scientists and land managers are experimenting with fire to discover key variables that are necessary to support the rangeland ecosystem (i.e. control undesirable vegetation) under livestock production conditions. However, one barrier to successful implementation of a fire regime is the view of fire as a management tool, interchangeable with grazing, herbicides and mechanical disturbance, rather than an integral ecosystem process and keystone disturbance. This symposium merges historical precedence, current evidence, and human perceptions and focuses on the contrast between fire as a brush management tool and an inherent rangeland ecosystem component.

0183

Is Livestock Production for the Birds?: Linking Grazing Management and Grassland Birds in North American Shortgrass Steppe and Mixed-Grass Prairie

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Many grassland bird populations in the western Great Plains have declined substantially over the past half century. Today, the majority of the remaining grassland bird habitat supports livestock production. Since grassland bird abundance is linked to vegetation structure, and livestock grazing shapes vegetation structure, an understanding of the ecological and socioeconomic links between grazing management and grassland bird habitat is needed. We first present findings from the shortgrass steppe of Colorado, USA, highlighting tradeoffs between the influence of different rangeland management strategies (via cattle grazing, fire-grazing interactions, and prairie dogs) on grassland bird habitat versus cattle weight gains. These studies emphasize the importance of heterogeneity in vegetation structure and management practices to sustain the full suite of native shortgrass steppe birds. Second, we present findings from the mixed-grass prairie of Saskatchewan, Canada, to demonstrate how variation in rangeland management underlies variation in habitat for grassland songbirds. We discuss how management for grassland bird conservation presents management opportunities and tradeoffs for livestock production. Management for the recovery of grassland birds requires efforts to understand factors driving local decisions by individual producers and managers, and to recognize the importance of landscape-scale variability in grazing management strategies and vegetation structure.

0184

The New Integrated Paradigm for Research, Education and Extension

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Changes from the 2008 Farm Bill for USDA's extramural funding agency, the National Institute of Food and Agriculture (NIFA), is a new opportunity/imperative to grow agricultural research. NIFA's flagship competitive grants program, the Agriculture and Food Research Initiative (AFRI), will be the focus of growth in future research support and will reflect NIFA's desire to work at meaningful scales on a discrete set of overarching scientific issues, selected for its potential to improve people's lives. Awards will have greater requirements for integration of research, education and/or extension (REE) than in the past. Challenges for NIFA include: 1) creating and sustaining a culture of innovation that stimulates, reinforces, and rewards creativity, and guides its decision-making process, and 2) experimenting with innovative methods to finding the best REE ideas to fund must be a central feature of USDA and other federal agencies. Biology represents nearly 27% of federal research obligations. Biological research appears to be on the verge of a revolution, moving from simple taxonomy to research that is data driven and engineerable. The 2009 NRC report "A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution" proposes a national initiative to promote the New Biology. This New Biology must focus on problem-centric, interdisciplinary research in biophysical and social sciences to solve challenges in health, food, energy, and environment. New Biology in NIFA consists of sustaining disciplines while blurring their boundaries, innovation as a central feature of REE, and building collaborative relationships.

0185

Variability in Light-Use Efficiency for Gross Primary Productivity on Great Plains Grasslands

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Gross primary productivity (GPP) often is estimated at regional scales by multiplying the amount of photosynthetically active radiation (PAR) absorbed by the plant canopy (PARa) by light-use efficiency (ϵ_g ; GPP/PARa). Mass flux techniques are being used to calculate ϵ_g . Flux-based estimates of ϵ_g depend partly on how PAR absorption by plants is modeled as a function of leaf area index (LAI). We used CO₂ flux measurements from three native grasslands in the Great Plains of the USA to determine how varying the value of the radiation extinction coefficient (k) that is used to calculate PARa from LAI affected variability in estimates of ϵ_g for each week. The slope of linear GPP-PARa regression, an index of ϵ_g , differed significantly among the 18 site-years of data, indicating that inter-annual differences in ϵ_g contributed to the overall variability in ϵ_g values. GPP-PARa slopes differed among years and sites regardless of whether k was assigned a fixed value or varied as an exponential function of LAI.

Permitting k to change with LAI reduced overall variability in ϵ_g , reduced the slope of a negative linear regression between seasonal means of ϵ_g and potential evapotranspiration (PET), and clarified the contribution of inter-annual differences in precipitation to variation in ϵ_g . Our results imply that greater attention be given to defining dynamics of the k coefficient for ecosystems with low LAI and that PET and precipitation be used to constrain the ϵ_g values employed in light-use efficiency algorithms to calculate GPP for Great Plains grasslands.

0186

Grazing Management Effects on the Soil Health in Mixed-Grass Prairie within the Missouri Coteau Region of North Dakota

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Soil morphology, soil structure, soil components, and soil hydrology were examined to investigate long-term effects of grazing management on the soil health. The four grazing management treatments studied (season-long moderate grazing [MG], season-long extreme grazing [EG], twice-over rotational grazing [RG], and idle [ID]) at the landscape level (summit, backslope, and toeslope) have been imposed on mixed-grass prairie within the Missouri Coteau Region of North Dakota for more than 20 years. The EG soil mollic horizon was deeper than MG and RG on the summit and backslope. The EG, MG, and RG had finer soil texture on the backslope and coarser soil texture toeslope than ID. The RG had higher soil organic matter (SOM) content than EG and ID at the 0-5 cm soil depth on the summit, while EG higher SOM content than ID in the 0-25 cm soil profile on the backslope. The MG had higher soil calcium carbonate equivalent than ID at the 10-45 cm soil on the summit. Grazing increased soil aggregate size and water retention. Grazing increased soil aggregate stability on the summit and decreased on the toeslope. The ID had higher five-minute soil infiltration than MG, RG, and EG on the backslope and toeslope while higher one-hour soil infiltration rate than RG, MG and EG at the whole landscape level. The ID had higher soil saturated hydraulic conductivity than MG, EG, and RG on the toeslope. Grazing management effects on the soil health are complex, and depend on landscape position, soil depth, and evaluated parameter.

0187

Plains Prickly Pear: Demography and Response to Grazing on the Shortgrass Steppe

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Plains prickly pear cactus (*Opuntia polyacantha* Haws.) is a key contributor to the structure and standing crop of vegetation of the shortgrass steppe. Past research has suggested that prickly pear increases with grazing intensity lowering the forage value of the shortgrass steppe. Recent research has shown that prickly pear can provide a refuge for other species to reproduce and escape herbivory. However, little is known about the demography of prickly pear and how it may respond to a change in grazing disturbance. In 1994, several grazing exclosures on the Shortgrass Steppe Long Term Ecological Research site were modified to protect previously grazed areas (protected treatment) and expose previously ungrazed areas to grazing (unprotected treatment). A total of four grazing treatments resulted; grazed, ungrazed, and the two transitional protected and unprotected treatments. In 2000, digital images were annually taken of 6, 1-meter plots in each of the 4 treatments. We converted the images to a GIS format and evaluated cladode demography. From 2000 to 2010 cladode area increased in the grazed and protected treatments and decreased in the ungrazed and unprotected treatments. In addition, year-to-year fluctuations of cladode area were large and migration of individual prickly pear clones exhibited great variability.

0188

The Evaluation of Ring-Necked Pheasant and Duck Production on a Multiple Land Use Management System on Post-Contract Conservation Reserve Program Grasslands

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The Conservation Reserve Program (CRP) originated as part of the 1985 Farm Bill. At its peak enrollment, the CRP consisted of approximately 748,971 contracts and placed roughly 14,669,854 hectares of land into a permanent cover. The CRP has been touted as the largest conservation program ever undertaken in the United States and as such has provided habitat for numerous species of wildlife. As part of the 2008 Farm Bill congress pledged to maintain CRP enrollment at 32 million acres. In July of 2010, the first general signup for CRP to occur in four years was announced in an attempt to fulfill this promise. In recent years, many CRP contracts have begun to expire, and although a general signup is currently underway, many landowners will be forced to make decisions regarding their land. Not all eligible land will be accepted back into the program. From 2006-2010, we conducted research aimed at evaluating the viability and sustainability of producing both agricultural and wildlife outputs on post-CRP grasslands that are currently managed as grazing lands, no-till cropland, hayland, and idle grassland. We located and monitored 176 pheasant and 294 duck nests during the study. The majority of pheasant and duck nests occurred on lands devoted to permanent cover. Findings from this study will be discussed in detail and suggest the importance of maintaining areas of permanent cover on expiring CRP lands if wildlife outputs are a continued goal.

0189

Fire Rehabilitation Decision Making

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We are investigating programmatic, institutional, regional, management group and individual manager influences on fire rehabilitation practices in order to determine current and potential use of promising seeding practices. Wildland fire rehabilitation funds are available to allow public land managers to seed burned rangelands 1 to 3 years after a wildfire. Objectives include protection of human health and property, as well as soil conservation and maintenance of ecosystem health. Managers must quickly decide where, what, and how to seed, and justify their decisions in emergency stabilization and rehabilitation plans. Interagency and agency policies, guidelines, and funding structures, as well as executive orders guide the development and implementation of these plans. Managers may propose the species to be seeded but their use of native seed is constrained by costs and availability. Terrain features may limit the choice of seeding method, but may also be affected by archeological clearance and manager bias. Site potential limitations to seedling establishment greatly affect success, but managers are still under pressure to seed low-potential sites. There is a lack of information on what factors affect success and why some seedings succeed and others fail. Use of native species has increased as seed has become more available and less costly. Managers often select proven introduced species, but also sometimes use costly unproven native species. Monitoring of past seeding projects, post-hoc research, and establishment of a database for sharing results should better help inform managers of successful practices.

0190

Managing Rangelands for Greenhouse Gas Mitigation: Opportunities and Tradeoffs

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Identification of greenhouse gas (GHG) mitigation opportunities through improved grazing management are needed to discern the extent of potential tradeoffs affecting livestock production. Previous research has found many grassland ecosystems to sequester carbon dioxide (CO₂), underscoring the importance of these ecosystems to affect net global warming potential (GWP). However, clear determination of grassland ecosystems as net sinks or sources of GHGs is limited by a lack of information regarding management impacts on the flux of nitrous oxide (N₂O) and methane (CH₄), as well as CH₄ emissions from livestock and production-related CO₂ emissions from management operations. This team presentation will highlight research in the northern Great Plains of U.S. and Canada addressing grazing management effects on soil carbon, GHGs, and livestock production. A broad portfolio of grazing management systems have been evaluated in the region for their effect on factors contributing net GWP of livestock production. Grazing management systems have included native vegetation, seeded native and tame forages, and native+tame mixtures, each under different stocking densities. Evaluations have been conducted across a range of spatial and temporal gradients, thereby providing information on grazing management effects differing in resolution (sub-meter to landscape) and timescale (weeks to decades). Completed and on-going evaluations suggest native vegetation grazed at a moderate stocking rate may serve as a net GHG sink, implying net CO₂ uptake from the atmosphere. However, tradeoffs affecting livestock production and sources of GHGs (CH₄, N₂O) exist with this management system, and should be carefully considered relative to other forms of grazing management.

0191

Seeing into Shadows in Resource Monitoring Images

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Image-based monitoring of natural resources offers benefits of speed, objectivity and a permanent record of resource conditions; however, the information value of images is only as good as image quality. Automatic focus and exposure controls on digital cameras often result in clear, well-lit images, but shadows and highlights in a scene create a contrast range that often overwhelms the camera sensor, resulting in bright and dark areas where information extraction is difficult or impossible. Histogram-adjustment of raw image files with commercially-available programs can overcome some of this, and is a good first step towards shadow/highlight mitigation. High-dynamic range (HDR) images are created by merging several differentially-exposed images into a single image that displays a larger range of luminance than is possible in a single exposure. To mitigate shadow effects in near-earth imagery (2 m above ground level), we created HDR nadir images and used them to measure grassland ground cover. HDR images showed more detail, reduced the numbers of pure black, pure white, and pixels visually indistinguishable from black and white, reapportioned skewed luma values towards a normal distribution, and increased the Euclidean distance between litter and bare ground RGB values-allowing increased feature separation. All of these facilitated an increase in real feature classification through manual image analysis. Drawbacks to the method included decreased image sharpness, increased time requirement, and more difficult image acquisition. We conclude that HDR imagery can provide more accurate measurements of bare soil for ecosystem monitoring and assessment.

0192

Stable Isotope Diet Reconstruction Using Tail Hairs of Feral Horses on the Sheldon National Wildlife Refuge

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Many claims have been made concerning the impact of wild/feral horses on rangeland vegetation and ecological processes. Unfortunately, relatively little scientific research has been done to substantiate these claims. Through a deeper understanding of feral horse ecology including habitat selection and vegetation impacts, difficult decisions regarding feral horse management will be more informed and more effective. In order to learn more about impacts, we used stable isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures) from tail hairs to reconstruct selection preferences of feral horses on the Sheldon National Wildlife Refuge, Nevada. Tail hairs show an isotopic chronology and as such, seasonal dietary variations can be observed through time. Tail hairs were collected from feral horses as well as random vegetation samples from various vegetation classes on the Sheldon NWR in order to show dietary variation through time. Also, tail hair samples were collected from horses in various reproductive categories (studs, dry mares, wet mares, and foals) showing dietary differences between various reproductive categories of feral horses. The knowledge of dietary selection will enhance our understanding of feral horse impact on rangelands which will in turn aid administrators in difficult decisions regarding management of feral horse populations.

0193

Increasing Diversity in Crested Wheatgrass Stands in Eastern Idaho

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Crested wheatgrass stands are often monocultures that resist native plant reestablishment. Attempts to increase diversity in these stands require treatment to reduce crested wheatgrass. This study was conducted to determine whether 1) crested wheatgrass is reduced with disking, herbicide, or a combination; 2) treatments increased seedling success over 2 growing seasons; and 3) treatments affect cheatgrass density and ground cover. Factorial combinations of treatment year, disking, and glyphosate application were randomly assigned to plots and a random half was seeded with native shrubs, forbs, and grasses. Line-point intercept and density of seeded species, crested wheatgrass, and cheatgrass were measured in 2 growing seasons after treatment and seeding. Disking and early herbicide application in 2008 reduced crested wheatgrass density in 2009, but differences were not detectable in 2010. Disking and late herbicide application in 2008 reduced Sandberg bluegrass density in 2009. Cheatgrass density in 2009 was generally less than 6 m⁻² regardless of 2008 treatment. Early herbicide applications reduced cheatgrass density below 2 m⁻². Density of seeded grasses exceeded 25 m⁻², irrespective of treatment, but undisked plots had greater than 30 m⁻². Treatments in 2008 did not affect forb and shrub seedling densities in 2009, which were less than 1 m⁻² and 0.01 m⁻², respectively. Suppression of crested wheatgrass followed with seeding enhances grass, but not forb and shrub, diversity within a few years.

0194

Forage Production and Quality, Cattle Performance, Economic Return, and Soil Health from Annual Forages Used for Late-Season Grazing in North Dakota

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Annual forages utilized for extending the grazing season can be used to improve late-season forage quantity and quality for grazing livestock, and soil health in the Northern Plains. A grazing study was initiated that compared three annual forage treatments at the Central Grasslands Research Extension Center in south-central North Dakota from 2007-2010. Our primary objective included testing three annual forage treatments and late-season rangeland grazing on forage production and quality to compare cattle performance. The secondary objectives were to determine treatment differences in soil health and economic costs. Our study design was a split-plot randomized complete block design with three replicates. Native rangeland paddocks served as our control with three replicates selected randomly from 12 paddocks. Annual forage treatments were turnip, foxtail millet and cocktail mix. Foxtail millet averaged the greatest amount of forage production at 4000 kg/ha, while turnips were highest in nutritional content with an averaged 15% crude protein and 87% IVDMD in mid-October. The average cost to graze foxtail millet was \$0.90/d/cow, the lowest among all treatments. The average cost was \$1.14/d/cow for native range. From 2009 to 2010, soil bulk density decreased by >10% at the 0-3 cm depth and decreased 8% at the 5-8 cm depth for all annual forage treatments. Additionally, average total organic carbon level of the soil increased 12% on the annual forage treatments. Grazing annual forages was an economical alternative to winter feeding beef cattle and winter grazing beef cattle on range in the Northern Plains.

0195

Overview of the Role of Fish and Wildlife in Determining Plant Succession and Directing Plant Community Phases

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Jump-started by a 2007 Wildlife Ecological Site Description (ESD) workshop sponsored by the Society for Range Management and The Wildlife Society, the fish and wildlife elements embedded in ESDs are expanding to capture roles and impacts fish and wildlife with determining trajectories of succession in plant communities. In addition, use of fish and wildlife as early indicators of vegetative transitions and crossing vegetation thresholds are being explored for use and inclusion in ESD data collection and site interpretation. This presentation will provide an overview of the recent and planned inclusion of fish and wildlife indicators and plant community phase drivers in state and transition models and in the ecological dynamics narratives in ESDs.

0196

Carbon Offsets for Utah Cattle Ranchers? Sequestration Potential of Deeded Lands and Implications for Policy and Management

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Enhancing carbon sequestration on grazing lands may help mitigate effects of greenhouse gas emissions and facilitate the development of carbon-offset protocols and carbon markets. The Intermountain West, however, is notable for a lack of information concerning carbon sequestration potential. Our goals were to assess awareness and attitudes of ranchers toward carbon sequestration initiatives and the potential scope for carbon sequestration on a whole-ranch basis considering the acreage and condition of various land types. The latter effort involves use of an LP model that integrates survey data with site-relevant carbon sequestration values from literature review and expert opinion. The phone and mail survey was implemented among 456 Utah cattle ranchers during winter 2010 using a simple-random design. A response rate of 88% was obtained. About 30% of respondents were aware of carbon sequestration issues, while 35% had a positive attitude towards carbon sequestration initiatives. Many needed more information. The average private land holding was 1,371 acres, divided into five categories including irrigated cropland (8%), irrigated pasture (4%), non-irrigated cropland (5%), wet meadow (1%), and rangeland (82%). The rangeland was further subdivided into lower foothill, upper foothill, and desert components. These were scored by respondents into one of four grazing condition classes (excellent to poor) using criteria in the survey that were based on the relative abundance of cheatgrass or woody encroaching species. Our assessment suggests that opportunities for carbon sequestration on a whole-ranch basis are affected by the size of land holdings, condition of different land types, and associated investment costs.

0197

Survival and Habitat Selection of Ring-Necked Pheasant Broods in Southwest North Dakota

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Conservation Reserve Program (CRP) grasslands have provided increased habitat for many wildlife species including ring-necked pheasant (*Phasianus colchicus*). The ring-necked pheasant provides southwest North Dakota an economic stimulus due to its popularity with hunters as an upland gamebird species. In recent years, CRP contracts have begun to expire, resulting in many large, contiguous land areas converted back to agriculture. Government agencies and conservation groups alike have expressed their concerns over what the potential loss of CRP habitat may mean for wildlife species. As CRP grasslands are converted to agriculture, ring-necked pheasant is one species that may be negatively affected due to the potential loss of valuable habitat. From 2008-2010, radio telemetry was used to evaluate brood survival and habitat use by ring-necked pheasant on-post CRP lands currently managed as grazing lands, no-till cropland, hayland, and continued CRP program. A total of 63 broods were monitored over the three years; 33, 18, and 12 in 2008, 2009, and 2010, respectively. We collected habitat measurements and sampled insect populations at 156 locations used by broods and 181 random locations throughout this study. The majority of broods spent their first 17 days of life in areas of permanent cover including season-long grazing pastures and idle CRP. In 2008, 55% of monitored broods had at least one chick survive to 17 days, while in 2009 and 2010, the apparent survival rate was 68%, and 42%, respectively. Brood habitat must be maintained to sustain the current ring-necked pheasant population numbers.

0198

Great Basin Native Plant Selection and Increase Project: A Science/Management Success

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This multi-state, collaborative research project was initiated in 2001 by the USDI BLM's Great Basin Restoration Initiative and the USFS Rocky Mountain Research Station to improve the availability of native plant materials and the technology to successfully restore rangelands across the floristic Great Basin.

More than 20 federal, state, and private cooperators are working together to: 1) increase the availability of native plant materials, particularly forbs, for restoring disturbed Great Basin rangelands, 2) provide an understanding of species variability and potential response to climate change, 3) develop seed technology and cultural practices to improve native seed production by private growers in concert with the appropriate seed regulatory agencies, 4) develop application strategies and technologies to improve the establishment of native seedlings, especially where exotic invasives are present, and 5) develop demonstration areas, manuals, popular publications and websites to facilitate management application of research results. The emphasis of the project is now shifting to improving the technology and strategies to successfully establish native plants by initiating studies on adapting seeding strategies to climate change, increasing native plant diversity in established crested wheatgrass seedings, and improving seeding equipment to better establish hard to distribute native plant seeds. This research/management partnership has strengthened collaboration among scientists, involved the native seed industry in being part of the solution, and increased awareness of agency specialists of science-based strategies and native plant materials available for the restoration of Great Basin rangelands.

0199

Wetland Resources and Issues in the Prairie Pothole Region of the Northern Great Plains

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The Prairie Pothole Region of the Northern Great Plains is a young landscape left behind upon the retreat of glaciers approximately 10,000 years ago. The region covers approximately 900,000 km² of what was primarily grassland intermixed with a substantial density and diversity of shallow wetlands of different sizes, shapes, and hydroperiods. This keystone habitat is essential for a large population of biota (e.g. waterfowl) whose life-cycles have adapted to the cycles of these wetlands. Since European settlement of the area, many of the wetlands of the region have been drained or otherwise altered. The southeastern portions of the Prairie Pothole Region have experienced over a 90% loss of the original wetland and grassland acreage, whereas the far north and western portions still have a large percentage of wetland and grassland acreage left. The loss of rangeland and wetland habitat, and the dominance of agricultural habitats, raises serious issues about the future of this unique ecosystem and its wildlife and human inhabitants. The increase in awareness of these issues has led federal, state, and tribal governments, as well as private groups to assess and monitor wetland biologic, chemical, and physical attributes to try to get a handle on the effects of current land management. These assessments will aid the current generation in identifying the numerous services that the region's wetlands provide, and future generation data detailing the gain or loss of the integrity of these wetlands due to current conservation and restoration practices.

0200

A Focus on Lentic Riparian/Wetland Ecosystems

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srm, Havre, MT, United States

The biological communities associated with standing water ecosystems are important for a variety of ecological reasons. This two session symposium is designed to provide information on the resource values of these lentic wetland communities, how these communities are being classified/inventoried/monitored/assessed, how they function, and what work is ongoing in these areas. Presentations are offered by personnel from various agencies, universities and other groups working in the intermountain and prairie pothole areas of the US. Attendees of this symposium can get a better understanding of what lentic communities are and how to address them in planning for responsible management of landscapes containing these communities.

0201

Vegetative Variation between Nesting and Winter Habitat of the Greater Sage-Grouse

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Greater sage-grouse (*Centrocercus urophasianus*) are a landscape species with annual ranges that can span 1000 mi² (2700 km²). They are sagebrush (*Artemisia* spp.) obligates, requiring a mosaic of sagebrush habitat throughout their life span. Data collected from April 2008 through March 2010 as part of a radio-telemetry study was analyzed to determine the seasonal habitat distribution and migratory status of a population of sage-grouse in Western Natrona County, WY. Habitat use for nesting and early brood rearing has been well documented in prior studies, but minimal winter habitat work has been conducted. As lack of suitable winter habitat may have detrimental effects on greater sage-grouse populations, microhabitat features were collected at nesting/early brood rearing and winter grouse locations to facilitate detailing vegetative variation between seasonal ranges. These variables were then associated with Geographic Information System (GIS) layers to design a predictive model for sage-grouse seasonal habitat on a macro-habitat (landscape) scale. Male and female grouse locations were collected via aerial and ground telemetry and incorporated into GIS for spatial analysis. GIS technology was utilized to provide a visual display and geo-referenced data. Combined with the microhabitat data collected, the information will assist land and wildlife managers in making decisions with regards to conservation and management of the Greater Sage-grouse.

0202

The DF1 Tip Jet Personal Helicopter: An Innovative Platform for Obtaining Very-High Resolution Aerial Images

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Tip jet helicopters have flown since 1950 when the Hiller HJ-1 Hornet used ramjets mounted to rotor-blade tips instead of the large engine, gearbox, and tail rotor of conventional helicopters. The U.S. Army, Navy, and NASA all experimented with the concept, as did Sud-Ouest in France. Twelve earlier tip jet helicopters have been designed, but only Sud-Quest's Djinn was commercially produced. No such aircraft have been built since the mid-1960's. Tip jet helicopters were never accepted by customers because of their short range, noisy interiors, and undesirable autorotation characteristics. However, Avimech International Aircraft, Tucson, AZ, now markets a recently designed, small tip-powered helicopter, called the DF1. The DF1 overcomes some of the earlier obstacles through lighter, hydrogen peroxide-powered jets, a light tubular airframe, and blade modifications that increase lift. The tip jets convert hydrogen peroxide to steam and oxygen in the presence of a metal catalyst, generating 14.5 kg of thrust from each jet (equivalent to 204 HP). The airframe weights 100 kg. A hand control directs all maneuvers making it simple to fly. It cruises at 64 km/h (40 mph) and has a maximum climb rate of 2,300 ft./min. Endurance is 50 minutes or more, depending on fuel-tank size. The DF1 has been certified by the U.S. Federal Aviation Administration. It debuted at the 2010 Experimental Aircraft Association's Oshkosh national fly-in. Its stability in windy conditions, cruise speed, and hovering capability, potentially, make it an attractive platform for acquiring very-high resolution rangeland imagery.

0203

Multiple-Paddock Planned Grazing Distributes Utilization across a Heterogeneous Landscape

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We use multiple-paddock planned grazing where a herd of livestock are moved through a series of paddocks over the course of the grazing season to manage the spatial and temporal distribution of grazing. This contains elements of both rotational grazing and rotational rest, and is adaptively managed rather than a rigid grazing system. Planned grazing has improved the spatial distribution of utilization on the Howell Ranch with shorter grazing periods, higher stocking density, and smaller paddocks than the extensive management practiced previously on the ranch and currently on many ranches. Cattle regularly graze steep mountainsides and plants often considered unpalatable, without damaging riparian areas, at moderate overall utilization, while maintaining good animal performance. Steep areas dominated by Thurber fescue (*Festuca thurberi*), a bunchgrass which becomes rank and avoided if not frequently grazed, comprise most of the land and much of the forage base of the ranch. If steep areas were not utilized the ranch would sustain a much lower grazing capacity; and if they were only utilized when preferred, areas and plant species would be overgrazed, and rangeland health and livestock performance would suffer. The Howell Ranch is a commercial scale case study corroborating recent experimental evidence that well-planned and adaptively managed multiple-paddock grazing can improve the distribution of livestock grazing across a heterogeneous landscape and across plant species. This central benefit of multiple-paddock planned grazing may have been lost in previous grazing studies where paddock size and diversity were minimized, and thus resolves much of the debate over grazing management.

0205

Downwind Rangeland Smoke: Flint Hills Case Study

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The Flint Hills landscape of Kansas and Oklahoma is the largest remaining tract of tallgrass prairie left in North America. Early cattlemen recognized that burning Flint Hills pastures improved cattle weight gains and the condition of their pastures. Large areas in the Flint Hills, particularly in pastures grazed by transient cattle, were burned in early spring on a frequent basis despite academic warnings against the practice. Today, the practice of pasture burning, typically in late March or early April, is common throughout the Flint Hills, but is especially prevalent where intensive early stocking (IES) is done (IES = twice the number of stocker cattle graze for half the season). Average daily weight gains in IES pastures are commonly 15 percent higher, resulting in a strong economic incentive to annually burn. Analyses of satellite imagery indicate that some areas are receiving more fire than is ecologically necessary and others not nearly enough. Weather conditions sometimes force land managers to burn within a narrow window of time, causing air quality problems, particularly ozone levels, for communities down wind. EPA is proposing to make air quality standards more stringent, which will make it more challenging to burn without impacting EPA air quality standards. As a result, the state of Kansas is developing a Smoke Management Plan to address issues related to Flint Hills prescribed fire.

0206

Monitoring the Efficacy of Biocontrol on Diffuse Knapweed (*Centaurea diffusa*) in British Columbia's Southern Interior

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Diffuse knapweed (*Centaurea diffusa*) is a serious problem on low elevation, Crown-owned native rangelands of British Columbia's southern Interior, causing economic and biodiversity losses. Beginning in 1971 and continuing to the present, a series of biological control insect species were released and subsequently redistributed in an effort to control the weed. To determine the efficacy of this biological control effort, ten older (1983-1998) vegetation monitoring sites, which contained knapweed in the first sampling, were identified across southern British Columbia. In 2010, the monitoring sites, representing a range of elevations, aspects and grazing histories, were relocated and remonitored for vegetative cover, and the data compared. Knapweed biological control release locations were superimposed over the vegetation monitoring site locations, and the current status of the biological control agents' populations was measured at each monitoring site. In all cases knapweed declined from the earlier sampling, in some instances precipitously. Potential alternate causes for the decline (changing climatic patterns, changing grazing practices) are discussed. This metadata analysis points to a successful biocontrol effort, and suggests that the release of multiple types of insect agents (seed feeders and root feeders) may have had a synergistic effect.

0207

The Great Basin Landscape Conservation Cooperative: Building on Existing Collaborative Programs

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The floristic Great Basin has a long history of collaboration between management entities and more recently among land managers and the scientific community at a regional scale. These collaborative efforts have often focused on common issues in the Great Basin including, but not limited to, invasive species, wildfires, development, and climate change. The Bureau of Land Management, the largest land manager in the Great Basin, established the Great Basin Restoration Initiative in 1999 to address flammable exotic grasses and wildfires on public lands. More recently, the Great Basin Science and Management Partnership and Great Basin Environmental Program were established to address science serving management and restoration funding in this region. In 2009, the Department of Interior initiated Landscape Conservation Cooperatives (LCCs) to better integrate science and management to address climate change and other landscape scale issues. LCCs are applied conservation science and management partnerships between the Interior Department bureaus, as well as other federal agencies, states, tribes, non-governmental organizations, universities and stakeholders. The Great Basin LCC is one of twenty LCCs being set up across the US and corresponds to the widely accepted floristic Great Basin Boundary. The challenge in organizing the Great Basin LCC is connecting the existing regional partnerships and their value into a new organization that will be self-governing and supported by a DOI agency staff. The key to connecting the efforts of these four regional partnerships is communication and compromise.

0208

Communicating Effectively with Livestock Producers

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This session will focus on improving communication skills of agency personnel who interact with producers or ranchers - probably the most important skill in the toolbox. The program will emphasize success stories of ranchers and agency personnel who have worked together to improve management of grazing lands for the benefit of the resource and the financial stability of the ranch. Larger scale endeavors that would include watershed and multi-ranch level planning will also be examined to show examples of communication strategies that have been successful. Speakers will also discuss tactics about how to build trust and rapport with individuals as well as with groups or organizations to meet specific objectives. Ranchers will discuss: 1) what they expect from a working relationship with a range specialist or a conservation planner, 2) topics important to the rancher that an inexperienced range specialist may not initially consider, 3) the importance of ranch economics, 4) what not to say, and 5) how to build trust and rapport from the rancher's point of view. Range Specialists or conservation planners will speak about how they have been able to sell conservation and sound range management principles to producers during their careers. This session is primarily focused on an audience of newer government employees who have little to no experience working with ranchers, but more experienced employees will benefit from the session as well. Even though USDA-NRCS employees are the only agency speakers, other agency personnel who work with landowners should acquire information that they can use in their daily jobs.

0209

Demonstration of Restoration Approaches on a Wetland Reserve Project

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Currently, restoration of prairies in the Willamette Valley of Oregon is an art rather than a science. Restoration professionals disagree about best techniques to restore diverse prairie plant communities. There is even lack of agreement about whether grasses or forbs should be seeded first or whether all should just be seeded together and left to develop. Much of the land being restored to prairie habitats is retired agricultural land with varying histories of crops and weed species. Seeding a grass-only plant community allows for continued use of broadleaf-specific chemicals for several years to control weed infestations before forbs are re-introduced. In other projects, generally where sites have been planted in grass seed crops and broad-leaved weeds have been controlled for many years, restorationists contend that seeding the forbs first is the best approach. In this study, we wanted to test what seeding approach would give us the most cost-effective, yet diverse plant communities over time at a new restoration of a wetland reserve project just south of the city of Forest Grove, Oregon. During Fall, 2007, nine 1-acre rectangular treatment plots were established and seeded to three different, randomly assigned "treatments", with three replications of each treatment. The seeding treatments were 1) grass-only, 2) forbs-only, and 3) grasses and forbs together. These treatment plots have been monitored during the growing seasons of 2008, 2009, and 2010. During Fall, 2010, grass will be seeded into the forb-only plots and forbs will be seeded into the grass-only plots.

0210

Rangeland Web Resources: Making Your Proposals More Competitive

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From the 2008 Farm Bill, USDA's National Institute of Food and Agriculture (NIFA) represents a new opportunity and imperative to grow and sustain support for agriculture research, education, and extension. Both this year and into the future more competitive awards, including NIFA's flagship program Agriculture and Food Research Initiative (AFRI), will require greater representation of education and/or extension components. Most of the NIFA requests for applications (RFAs) include a general suggestion to link newly funded projects and eXtension, but no specific reference to existing web-based rangeland science and management resources is indicated. Proposals to NIFA for integrated competitive funds with new education/extension components to the Rangelands West (GROKS) web site, directed to rangeland science and management professionals, and the Rangeland Stewardship and Health Community of Practice (RSHCoP) site within eXtension with a more public audience, could be considered a valid budget expense. These efforts might include developing webcasts, webinars, online tutorials, and/or on-line curricula integral to either the Rangelands West or the RSHCoP eXtension web sites. Product development and implementation could count towards NIFA's requirements for integration of research, education and extension, if the appropriately skilled co-project directors are included on the proposal. Rangeland scientists need to be aware of RSHCoP eXtension and Rangelands West as potential partners in their extension and education efforts to make their proposals more competitive, and in turn, help support these web resources.

0211

A Historical Perspective on the Development of the Ecological Site Concept

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The dominant disciplines in natural resource management, forestry and range, have developed over the past century with the "site" concept as a core principle. Forest managers employed a site concept focused primarily on the influence of a specific set of climate and soil factors on forest production; in particular on the selection of appropriate species for replanting after burns and timber harvest. Pioneering range scientists adapted the site concept with an emphasis on the control climatic and edaphic factors exerted on plant community composition and sustainable forage production. The rangeland application used the concept of 'regional climax' modified by variations in soil development factors at finer scales to predict species composition and production and served as the basis for management interpretations. Recent advances in ecology have forced some rethinking in the basic principles of site description. While contemporary multi-stable state views plant community dynamics have been relatively well accounted for by employing state and transition models, the shift in emphasis away from similarity of a climax community as a way to group soil units requires reconsideration of organizing principles. Rather than a characteristic plant community, ecological dynamics provide more appropriate criteria for grouping land units into ecological sites. Within a specified climatic regime, landscape position and static soil properties are the best predictors of ecological dynamics in response to changes in management. The shift from climax vegetation to soil properties as an organizing basis for delineating landscape components will likely require a reconsideration of the design of ecological sites.

0212

Long Term Effects of Aeration and Fire on Invasion of Exotic Grasses in Mixed Brush Plant Communities as Affected by a Wildfire

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The presence of exotic grasses may be affected by disturbances such as mechanical treatments and prescribed burning, additionally, wildfires may exacerbate these effects. This study was conducted to determine the long term effect of aeration and prescribed burning on the invasion of exotic grasses as affected by a wildfire. Four treatments were evaluated in 2007 and in 2008 after a wildfire: aeration in 1999 or 2000, aeration in 1999 or 2000 followed by a warm season burn in 2005, warm season burn in 2005, and control (only wildfire in 2008). A randomized complete block design with four replicates was used. We examined changes in percent canopy cover of exotic grasses, native grasses, forbs, litter, and bare ground, as well as woody and succulent plants. There was a multivariate effect in the absolute canopy cover of exotic grasses, native grasses, forbs, litter, and bare ground in 2007 among treatments, namely cover of litter and native grasses. After the wildfire in 2008 there was a multivariate effect in the absolute canopy cover of exotic grasses, native grasses, forbs, litter, and bare ground in 2008 among treatments, namely cover of exotic grasses which were higher in the control than in the other treatments. Exotic grasses percentage in the control increased from 37% in 2007 to 78% in 2008 after the wildfire. Our results do not suggest that aeration and/or prescribed burning increase exotic grasses 7-8 years after the initial treatment and as affected by the wildfire, except in the non-treated areas.

0213

Effect of a Wildfire on Old Aerated and Prescribed Burned Sites: Vegetation Diversity and Exotic Grasses

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Vegetation diversity may be affected by disturbances such as mechanical treatments, prescribed burning, and wildfires. This study was conducted to determine the effect of a wildfire on the invasion of exotic grasses on previously aerated and prescribed burn sites. The study was conducted at the Chaparral Wildlife Management Area in the western south Texas plains. Four treatments were evaluated before and after a wildfire of spring 2008: aeration in 1999 or 2000, aeration in 1999 or 2000 followed by a warm season burn in 2005, warm season burn in 2005, and control (only wildfire). Within a randomized complete block design with three replicates, we examined changes from 2007 to 2008 in percent canopy cover of exotic grasses, native grasses, forbs, litter, and bare ground, as well as woody and succulent plants. There was a multivariate effect of the wildfire in the absolute canopy cover of exotic grasses, native grasses, forbs, litter, and bare ground among treatments (Wilks' Lambda $F_{15, 143.95} = 2.21$, $P = 0.0084$), namely canopy cover of exotic grasses ($F_{3, 56} = 3.66$, $P = 0.0176$) which were higher in the control than in the other treatments. Exotic grasses percentage in the control increased from 37% in 2007 to 78% in 2008 after the wildfire. The wildfire and the disturbances are not the only factor influencing these results, soil properties and precipitation also play an important role in the establishment or propagation of either native or exotic species after a disturbance by fire or mechanical means.

0214

Planting Date Influences Germination and Seedling Demography of Bluebunch Wheatgrass

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Establishment of perennial grasses from seed in post-disturbance Wyoming big sagebrush communities has met with only limited success, due partly to a severe lack of knowledge of the seedling ecology of perennial grasses. Here we examine the influence of planting timing on germination and seedling demographics of bluebunch wheatgrass. Our study site was located near Burns, OR. In 2008 - 2009 we planted seeds monthly, September - December, in 1m² plots (500 seeds/plot) using a randomized block design with five replications. Germination timing was assessed using seed bags pulled at 2-week intervals in fall and 1-month intervals in spring. Seedlings were marked in March-June of the year following planting; seedlings remaining in July were considered established. Planting in September and October had up to 80% germination prior to winter whereas December plantings germinated mainly in spring and at reduced rates (15-35%). Seeds planted in September and October emerged earlier (March-April) and November/December plantings emerged later (April-May). Emergence of germinated seeds was highest for September/October plantings but seedling survival was highest for later plantings. Density of established seedlings was lowest for November plantings in year one and highest for September plantings in year two. Relatively poor establishment of fall-germinated seeds suggests that delaying germination until spring may improve establishment success. Our data indicate that the critical stages of seedling development are affected by month of planting. While emergence was limited in all treatments, seedling survival was higher with later planting date (e.g., December) but germination was higher with September/October plantings.

0215

Rangeland and Pasture Weed Control with Aminopyralid + 2,4-D

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Aminopyralid is a systemic herbicide developed by Dow AgroSciences specifically for use on rangeland, permanent grass pasture, such as Conservation Reserve Program acres, and wildlife management areas. GrazonNext® herbicide is a liquid formulated product containing 40 g ae/L (0.33 lbs ae/gal) aminopyralid + 320 g ae/L (2.67 lbs ae/gal) 2,4-D. Labeled broadcast use rates of this herbicide product range from 1.2 to 3.1 L/ha (1.0 to 2.6 pints/acre). Broadleaf weeds reduce rangeland and pasture carrying capacity by competing with forage grasses and desirable forbs. The control of later emerging weeds can lead to improved access to forage by grazing animals. GrazonNext provides broad spectrum control required to manage weed species complexes in rangeland and pastures. GrazonNext controls many weeds in these complexes including musk thistle (*Carduus nutans*), plumeless thistle (*Carduus acanthoides*), horsenettle (*Solanum carolinense*), annual broomweed (*Gutierrezia dracunculoides*), western ragweed (*Ambrosia psilostachya*), common ragweed (*Ambrosia artemisiifolia*), spiny amaranth (*Amaranthus spinosus*), wild carrot (*Daucus carota*), buckhorn plantain (*Plantago coronopus*), woolly croton (*Croton capitatus*), and bitter sneezeweed (*Helenium amarum*). GrazonNext provides suppression of several woody species, including huisache (*Acacia farnesiana*), mesquite (*Prosopis glandulosa*) and blackbrush (*Acacia rigidula*).

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0216

ESD Development Technical Workshop

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Ecological site descriptions (ESDs) are being developed throughout the United States as a means of classifying and describing land types according to soil-geomorphic, climatic, and vegetation patterns. Individuals tasked with writing these documents often have difficulty obtaining and summarizing all of the information required for ESD production. Without a standardized method for ESD development nationally, many new and innovative tools have been developed by individuals seeking to produce ESDs as accurately and efficiently as possible. This workshop provides the training necessary to write an ESD by allowing the creators of ESD development tools to share their methods in a classroom setting. Part one will focus on obtaining useful information from commonly-available data sources to create site extent maps, extract and analyze soil and physiographic data, interpret site-specific climate data, and fill out the hydrologic features and growth curves sections of the ESD. Part two will focus on integrating information from various sources to produce ecological site keys, state-and-transition models, and interstate ecological site correlations. This workshop is not intended to endorse specific ESD development tools, but to exhibit useful methods and facilitate the exchange of ideas among ESD development professionals.

0217

The Invasion of Smooth Bromegrass and Kentucky Bluegrass in Restored Grasslands as a Function of Species Diversity

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This study investigated the relationship between plant diversity and susceptibility to invasion by smooth bromegrass (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) in experimentally restored grassland plots. This study was conducted on 610 plots in two locations; 400 plots were located in southeastern North Dakota representing the northern tallgrass prairie and 210 plots were located in west central North Dakota representing the mixed-grass prairie. The 400 plots in southeastern North Dakota were planted with 100 different species mixtures and fertilized with nitrogen or phosphorus, at high or low levels. The 210 plots in west central North Dakota were planted with 70 different species mixtures and fertilized with nitrogen, phosphorus, or no fertilizer. Results from this experiment indicate that Bromus was inversely correlated with the number of seeded species, seeded species biomass, total number of species, and total biomass at the southeastern plots. The presence of Poa was unrelated to the number of seeded species or total number of species, however, Poa presence was positively correlated to seeded biomass and total biomass at the southeastern plots. At the west central plots, the presence of Bromus was inversely correlated to the number of seeded species and seeded biomass, while unrelated to the total number of species and the total biomass. The presence of Poa at the west central plots was unrelated to the number of seeded species, total number of species, seeded biomass, or total biomass, but was inversely affected by treatment when crested wheatgrass (*Agropyron cristatum*) was a covariant.

0218

Cattle Grazing and Yosemite Toad (*Bufo canorus* Camp) Occupancy across a Hydrologic Gradient of Sierra Nevada Mountain Meadows

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With mounting evidence of global population declines, amphibian conservation is gaining considerable attention. In the Sierra Nevada, the Yosemite Toad (*Bufo canorus* Camp) has disappeared from much of its historic range. Cattle grazing is thought to degrade the quality, and thus reduce occupancy, of meadow breeding habitat critical to Yosemite Toads. However, there is little quantitative information correlating cattle use, meadow breeding habitat quality, and toad use of breeding habitat. We surveyed 24 meadows to: 1) identify meadow biotic and abiotic factors influencing cattle utilization and Yosemite Toad occupancy; and 2) identify meadow types preferred by both cattle and toads to help direct grazing management and conservation efforts. During 2007 and 2008, cattle utilization (herbaceous use, fecal loading), plant community (species composition, forage quality, biomass production), and hydrologic condition (water table depth, spatial and temporal extent of surface flooding) data were collected from 5 sites within each meadow. Whole meadow toad surveys were conducted both years. A Bayesian structural equation model approach was used to test a priori hypothesized relationships between cattle grazing, Yosemite Toad occupancy, and meadow biotic and abiotic factors. Our results show that hydrologic condition, and not cattle grazing intensity, significantly influences toad meadow occupancy. Main findings include: 1) cattle use and toad occupancy are inversely related to meadow hydrology; 2) toads prefer habitats associated with relatively wet meadows; 3) cattle select nutritious diets associated with drier meadows; and 4) cattle grazing and toad occupancy primarily overlap in moderately wet meadows.

0219

Economic Flow-Model for Western Rangelands: Using Economic Principles to Guide the Allocation of Conservation Resources

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We present a directional flow-model to help public land managers efficiently allocate scarce resources between competing projects. This model will provide a thought process to incorporate economic concepts and current information on the economic benefits and costs of treatments (fuels removal, weed management, etc.) on western rangelands into land management decision-making. The model has four steps. First, the land manager must define the desired outcome of each treatment and the probability of the planned action reaching this outcome. Second, the land manager must identify the categories of benefits from each treatment (i.e., livestock, recreation, flood control, etc.). Each category of benefits will have a corresponding sub-module that will assist the land manager in the calculation of the estimated economic benefits in the category resulting from the treatment. Third, the land manager must calculate projected treatment costs. These include the costs of labor, materials (herbicide, etc), hiring contractors, and depreciation of equipment. Fourth, once benefits and costs are calculated for each treatment, the land managers will rank the treatments in terms of their benefit-cost ratios (the benefits of a treatment divided by the costs). An efficient allocation of agency resources is achieved by prioritizing projects in order of their benefit-cost ratios. This research is conducted as part of the USDA ARS's "Area-wide Pest Management Program for Annual Grasses in the Great Basin Ecosystem."

0220

Ten-Year Invasive Vegetation Changes on a South Texas Range

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Invasive grasses introduced to South Texas to improve forage production for cattle have invaded much of the rangelands in the region. Invasive grasses often displace native vegetation while reducing the quality of wildlife habitat. In 2009, we performed 21 vegetation transects that had also been performed in 1999, 2002, and 2004. When grouped together, all exotic grasses appeared to steadily increase in composition over the 10 year period. This trend was likely due to the large component of KR/ Kleberg bluestems in the exotic grass group. KR/ Kleberg bluestem steadily increased throughout the 10 years. Tanglehead and Kleberg bluestem increased ($P < 0.05$) from 1.4 and 1.8% in 1999 to 2.7 and 3.6% in 2002 and then to 8.1 and 9.4% in 2009, respectively. Values for native grasses and forbs were 60.8 and 32.7%, 80.8 and 7.6%, and 49.4 and 26.4% for the same three year periods, respectively. Buffelgrass remained a relatively low portion of the vegetation during the survey period in the study area, probably due to less suitable soils. Likewise, guineagrass never composed more than 0.1% of the vegetation. While KR/ Kleberg bluestem remain the most invasive species in the area, tanglehead has increased in more recent years. Although heavily grazed on the study area, invasive grasses have continued to increase over the ten year period. As these grasses continue to increase, it may become necessary to adjust wildlife management practices to address the impacts of the invasion on habitat.

0221

Rangeland Technology and Equipment Workshop: Diversification of Crested Wheatgrass Stands

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The Rangeland Technology and Equipment Council (RTEC) is an informal organization of land managers, engineers, academia, and private industry representatives interested in developing new rehabilitation equipment and strategies. The roots of RTEC go back to 1946 when the need for new site preparation and seeding equipment to increase forage production on western USA rangelands was a priority. Today RTEC emphasizes innovative technology and strategies to improve land treatments on western rangelands through the supporting functions of equipment development and application of innovative technology. The theme for this year's workshop is "Diversification of Crested Wheatgrass Stands". Invited speakers will discuss basic ecology, completed and ongoing research, and practical experience, and will review successes and failures in seeding native species into established crested wheatgrass stands. At the end of the workshop a short RTEC organizational meeting for the 2012 SRM meeting will be held.

0222

Riparian Forest Regeneration in the Middle Sheyenne River Watershed of North Dakota, USA

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There is a concern by federal, state, local, private, and non-profit groups about the lack of regeneration of riparian hardwood forest communities of the Middle Sheyenne Watershed in N.D. Historically, the dominant tree species native to this watershed include bur oak (*Quercus macrocarpa*), American elm (*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*). Both bur oak and American elm have been found to a lesser extent in the past forty years, with the latter species experiencing mortality due to disease. However, today seedlings of these species are sometimes present, yet apparently short lived.

It is not known whether the observed reduction in seedling recruitment in bottomland forest riparian areas is directly related to grazing or browsing by herbivores, or rather if the lack of natural tree regeneration may be due to other factors. It is hypothesized that land management allowing utilization of seedlings by herbivores maybe playing a significant role in reduced seedling survivability in forested riparian areas, whether planted or naturally regenerating. Our study incorporates browsing by white-tailed deer (*Odocoileus virginianus*) and/or grazing by cattle as treatments. Local tree plantings demonstrate the use of possible exclosure methods, including electric and non-electric fences or cages. Exclosures were also placed in riparian areas with naturally occurring seedlings, to help determine seedling survivability and recruitment. The results of this research will aid in deciding the appropriateness of restoration plantings in this ecoregion.

0223

Seedling Emergence of Diverse Seed Mixes in Post-Wildfire Rangelands

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Although rangeland seeding is common, it most often includes only a few species. Seeding diverse seed mixes could help to improve diversity of disturbed rangelands, but is a challenge because the different size, shape, appendage type, and sowing requirements of each species necessitate special handling. We evaluated emergence of a diverse seed mix seeded by a standard rangeland drill and by a newer "minimum-till" drill that was designed to drill and broadcast/press seed in alternating rows. The seed mix included grass, forb, and shrub species, and was seeded at two seeding rates plus a control of no seed. Both drills were evaluated at two different seeding locations in a replicated RCB design. Large-seeded species that were placed into the soil by the seed drills displayed up to 220 individuals per m², and no differences were observed between the drill types, although seeding rate and seeding location were significant. In the first year following seeding, small-seeded species that were either broadcast or pressed onto the soil surface had greater density in the areas seeded with the minimum-till drill (up to 27 seedlings per m²), as compared to the standard rangeland drill (about 11 seedlings per m²), which was not different from the unseeded areas. However, such differences largely disappeared by the second year post-seeding. Success in seeding such diverse seed mixes will require careful attention to the ecological requirements of each species, and machinery that can actually handle the seeds.

0224

BLM and the Pollinator Partnership

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Pollinators are critical for maintaining the biotic capacity and integrity of rangelands. Although grasses are wind pollinated, the forbs and shrubs that make our rangeland plant communities unique often depend upon native insects (and in some places, birds or bats) for the transfer of pollen required for plant reproduction. The Bureau of Land Management (BLM) and the Pollinator Partnership (P2) have been working together at a national level since 1997 to protect pollinators and pollinator habitat. In this talk we present information on many of the successful partnerships and projects that BLM and P2 are involved with nationally and explore opportunities to increase pollinator conservation, education and management projects in Field Offices. We will also present standard operating procedures and best management practices for managing and maintaining pollinators through vegetation management projects.

0225

Applications of Molecular Tools for Rangeland Ecology and Management

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Molecular tools are becoming commonly available and are frequently applied in management of natural resources. These applications are increasing due to the development of new technology, cross-training of professionals and reduction in laboratory costs. However, how can molecular tools be applied to answer questions in rangeland ecology and management? These tools can be very effectively applied to meet production goals, address rangeland assessment, monitor wildlife populations, develop landscape-level planning tools, and inform adaptive management. We give concrete examples of these applications, discuss the type of molecular data needed, and best practices for collecting/analyzing those data. Production goals may be more effectively met by identifying plant strains that are drought tolerant. Molecular methods can be used in rangeland assessment to identify presence of cryptic species and quantify genetic diversity within a species. Wildlife species of concern can be monitored for presence, genetic diversity, and movement within a management area. Ability of wildlife to move through a managed landscape can be difficult to assess. Genetic connectivity data can be applied on a landscape level to evaluate ability of species to move through the current landscape and evaluate potential future landscapes under alternative management plans. We conclude with a case study on chorus frogs (*Pseudacris maculata*) in mixed land ownership (Larimer County, Colorado), evaluating the effect of alternative land management strategies. We find that connectivity is higher in areas with active ranch land use compared to alternative lands uses.

0226

Optimized Plant Frequency as a Surrogate Measure for Species Abundance - Potential Applications to VHR Image

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Assessment of the effects of specific rangeland management practices requires long-term monitoring of species abundance. Foliar cover is the most commonly used measure of plant species abundance. However, cover may respond strongly to short-term environmental fluctuations, particularly in grasslands where aboveground biomass is regenerated annually and grazing intensity can be highly variable. Plant frequency is a pragmatic surrogate for plant density. Frequency estimates are based on presence/absence data from plots of fixed size. Using a combination of statistical models and computer simulations, we have identified sampling designs that maximize statistical power for detecting changes in underlying plant density based on the analysis of plant frequency. The optimal plot size for collecting frequency data decreases with increasing spatial variation in local density (spatial structure). We used spatially nested arrays of plots to simultaneously estimate the frequencies of 27 species at Tallgrass Prairie National Preserve, Kansas, based on a nearly-optimal plot size for each species. Of the nine perennial grasses in this group, five exhibited significant interannual variation. When the presence/absence of foliage is recorded from plots on a VHR image the resulting frequency estimate converges on foliar cover rather than plant density. Despite this loss of density information, foliar frequency estimated from plots will be more reliable than foliar cover estimated by point sampling to the extent that presence/absence inferences are more reliable when made from clusters of pixels (plots) than when made from individual pixels.

0227

Predicting Wolf (*Canis lupus*)-Cattle (*Bos taurus*) Encounters and Consequential Effects on Cattle Resource Selection Patterns

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The gray wolf population in Idaho has grown dramatically from the original 35 reintroduced individuals in 1995-1996 to 94 documented packs and a minimum population of 835 individuals in 2009. Wolf depredation on livestock has also increased dramatically with this population growth. Substantial spatiotemporal variability in wolf predation risk likely exists within large livestock grazing areas (e.g., public land grazing allotments) but this variability, its driving factors, and its consequences to livestock resource selection patterns have never been evaluated. Beef cattle and wolf resource selection patterns were evaluated using Clark GPS tracking collars logging locations every 5 min (cattle) or 15 min (wolves). Potential wolf-cattle encounters were determined based on wolf-cattle GPS location pairs that occurred within 500 m and 15 min of each other. Wolf scat locations were also surveyed and geo-located weekly along standardized routes. Potential wolf rendezvous sites were identified from a predictive wolf resource selection map. Potential wolf-cattle encounters were highly correlated to the location and timing of fresh wolf scat detected on survey routes. These encounters were also highly correlated with predicted wolf rendezvous sites. Although confirmation is needed, scat routes and wolf resource selection maps appear to be very useful tools for livestock producers and natural resource managers to assess the spatiotemporal variability of risk to wolf depredation on large livestock grazing areas. These tools have the potential to provide an early warning prior to or during the grazing season, perhaps allowing livestock management to be adjusted before serious depredation losses take place.

0228

Response of Juniper Woodland-Fuel Loading to Mechanical and Prescribed Fire Treatment

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Juniper woodlands have been expanding at an unprecedented rate over the past 130 years. As a result, rangelands have experienced changes in fire hazard as juniper density and cover has increased. The occurrence of large crown fires has subsequently increased in some areas. To mitigate this problem many land owners, both public and private, have undertaken juniper control programs utilizing a variety of techniques. This study analyzes the fuel reduction effectiveness of two common techniques, prescribed fire, and mechanical cutting with chain saws. Fourteen sites across the Intermountain West were selected to represent western juniper, Utah juniper, and pinyon-juniper woodlands in the Great Basin. Data reported are from two years after treatments were implemented. The study found an increase in herbaceous biomass in both treatments. Dead woody fuels (10hr, 100hr, and 1000hr) increased significantly in the prescribed fire and mechanical treatments. Increases in these fuels indicate that while fuel treatment is effective in reducing tree density, it may not be as effective in reducing overall fuel from the site in the short term.

0229

New Paradigms for Collaborative Research and Management in the Great Basin

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Current trends in research and management in the natural resources require the formation and maintenance of large, multi-disciplinary, multi-organizational, and regional research and management partnerships. The evolution of this regional-cooperative paradigm, however, has outpaced the development of tools and infrastructure to support and sustain these efforts. A regional workshop to address these issues was held in Reno in 2006, that led to the formation of the Great Basin Research and Management Partnership, which was formalized in 2010 with the establishment of an MOU between Federal and State agencies and Universities in the Great Basin. The purpose of this symposium is to examine the current state of large-scale, cooperative programs in the Great Basin, and to discuss mechanisms to foster and strengthen these efforts in the future. The morning session will discuss the overall picture of Great Basin issues, the current collaborative paradigm, and GBRMP. The afternoon session will focus on some current Great Basin collaborative efforts, their successes, and challenges to implementation.

0230

Mechanically Shredding Utah Juniper

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Juniper species are taking over thousands of hectares of sagebrush steppe. In absence of fire, juniper density increases thereby decreasing understory vegetation while increasing canopy fuel loads and the potential for catastrophic wildfire. To reduce canopy fuel loads, the Bureau of Land Management is mechanically shredding Utah juniper on hundreds of hectares annually in Utah. The expectation is that converting canopy fuels into surface fuels will reduce the rate of fire spread and allow better control of wildfire. Juniper is shredded by a large rotating drum with hardened spikes that is mounted on a large articulating tractor. This treatment leaves patches of shredded fuels over preexisting canopy litter and interspace soil. Trees were shredded at 4 locations in Utah. At each location we measured fuels in five 30-m transects in each of 14-16 subplots. Total shredded fuels roughly doubled from areas of low juniper dominance to high juniper dominance. Depth of shredded fuels was a good estimator of shredded fuel loads ($\text{Adj } R^2 = 0.92$) and permits relatively efficient sampling of shredded fuels compared to destructive sampling. Mechanically shredding juniper converts canopy fuels to surface fuels, which is expected to decrease the rate of fire spread. However, shredded fuels may increase flame lengths by increasing fuel surface area and elevated soil heating associated with longer fire line residence in high bulk density fuels.

0231

Grasshoppers! Grasshoppers! Grasshoppers!

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For the last three years Tooele County has had serious grasshopper infestations. Hot, dry weather and large areas of rangeland and uncultivated arable land create ideal conditions for insect development. Rangeland forage and agricultural crops can be damaged or disappear when large insect infestations develop. In late summer of 2008 large numbers of grasshoppers were reported in a small portion of the Tooele Valley. No control efforts were implemented because grasshoppers were already mature; however, that set in motion plans for the following season. Tooele County commissioners asked the USU Extension agent to coordinate control efforts. In March of 2009 a public meeting was held with representatives from APHIS, UDAF, USU Extension and Tooele County. Landowners were informed about the expected problems and assistance available from the agencies. Grasshopper monitoring began in April. Threshold numbers were noted in early May and increased through June. With help from UDAF and APHIS spray timing was determined to affect the greatest number of grasshoppers. Nearly 18,000 acres were aerially treated Dimilin 2L, an insect growth regulator. The cost of the aerial application was \$46,000. UDAF reimbursed Tooele County for 90% of the cost; the balance was paid by private landowners and the county. In 2010 grasshopper development was delayed nearly one month compared to 2009 and localized in the western part of the Tooele Valley around Grantsville and in Rush Valley. Nearly 10,000 total acres were sprayed, 3000 acres of rangeland with Dimilin 2L and 7,000 acres of irrigated cropland with Malathion.

0232

Revelations in Lentic Soils: Deciphering System Processes and Resource Conditions from Mud, Muck, and Peat

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Soils are libraries of environmental information from contemporary to prehistoric time. They are the synthesis of chemical reactions, physical and geologic processes, and biological activities. Lentic soils are a subset of soils in which the presence of water and riparian plants creates a distinct suite of soil properties and conditions. Lentic soils provide clues to the processes that act on the landscape and the land-management activities that alter their character. Lentic soils are also witnesses of environmental change and barometers of land management. Soil investigations can document insidious declines or subtle improvements in resource conditions from recently implemented land management. Soil investigations can provide a long-term context to interpret processes that might span or exceed the careers of individual professional scientists and land managers. Examples of soil properties and conditions in lentic systems will be used to illustrate short- and long-term processes, to differentiate natural and human-induced changes to the landscape, and to contrast the effects of good from poor land management. The goal is to illustrate ways in which lentic soils can be used to reconstruct natural processes and to inform land management practices.

0233

Spatial Movement of Free-Roaming Cattle (*Bos taurus*) When in Proximity to Wolves (*Canis lupus*)

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In 1995 and 1996, 31 wolves were reintroduced into Yellowstone National Park and 35 in central Idaho. These populations have grown to more than 1,500 with more than 835 in Idaho. As wolf populations have grown, so has predation on livestock, complicating cow and ranch management. Our study was designed to document cow spatial behavior with and without wolves. The study site covers approximately 173 km² (67 mile²) of pastures located in western Idaho. Ten randomly selected cows from a herd of 450 were collared with GPS trackers that recorded positions every 5 minutes from 1 April to late November 2009. A 43 kg (95 lb.) male grey wolf was tracked every 15 min with a GPS collar from 22 May to 18 December 2009. The wolf was part of a pack that contained 12 individuals which were involved in livestock depredation. Each position logged was tagged with the animal number, latitude and longitude, date, time, velocity, and fix quality information. Collared cattle first encountered (proximity < 500m) the collared wolf on 23 June 2009. Over the next 137 days collared cattle encountered this wolf 783 times at distances less than 500 m and 53 times at distances less than 100 m. Wolf encounters were typically at night. Cow daily travel distances prior to and during periods of wolf encounters are compared as is cattle spatial behavior.

0234

Graze Period Stocking Rate, Stock Density Affect Dietary Intake Independently

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Livestock diet selection over time is driven by graze period stocking rate and quantity and variability of plant quality in a paddock relative to animal requirements. The mathematical relationships among the foregoing factors presented here do not support the assumption that paddock subdivision and increased stock density invariably reduce nutrient intake, diet quality and animal performance, nor do they necessarily increase uniformity and intensity of utilization. Though rate of forage disappearance increases with stock density, when graze period decreases faster, proportionally, than stock density increases, the proportion of total forage on offer that animals can mix to meet their requirements over time can increase compared to management with longer graze periods at lower stock density, but with the same seasonal stocking rate. The relationships among stock density, time, and forage quality mean that graze period utilization and nutrient intake change quicker at higher stock density, but can be manipulated in any desired direction. Increased paddock numbers with short graze and adequate recovery periods can either increase or decrease heterogeneity of utilization and diet quality over time and space. Animal and plant community responses will occur quicker at higher stock densities. The direction of responses is determined by how time, stock density, and plant diversity at paddock and landscape scales are managed relative to each other. For these responses to reliably move the operation toward landscape and livestock performance goals will require monitoring and adaptive management.

0235

Classification of Lentic Riparian Areas: Challenges and Opportunities

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Lentic riparian habitats are often grouped on the basis of characteristics such as vegetation, soils, habitat suitability, function, value and/or hydrology to achieve specific purposes, e.g., mapping, mitigation, regulation, assessment, probabilistic sampling, etc. Unfortunately, multiple classification schemes have been devised and are in use across the country: the Cowardin classification system (USFWS), the Landfire/Ecological Systems classification (USFS, Natureserve), the HGM method (ACOE and many state DOTs). This presentation will provide an overview of these three main classification methods, and will discuss the advantages and limitations of each in differing contexts. It will also demonstrate how the Montana Natural Heritage Program uses a combination of vegetation-based classification (the Cowardin system) and hydrogeomorphic modifiers to provide information-rich maps that managers can "mine" for information. Finally, it will show how we use this combined classification approach to profile wetlands across large landscape areas, and how these profiles can be used for management, mitigation and restoration planning.

0236

An Algorithm for Approximate Rectification of Digital Aerial Images

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High-resolution aerial photography is one of the most valuable tools available for managing extensive landscapes. With recent advances in digital camera technology, computer hardware, and software, aerial photography is easier to collect, store, and transfer than ever before. Images can be automatically taken from aircraft at high frequency with cameras pointed vertically downward and stored on a laptop computer. The challenge in using this technology is the considerable time spent determining photo locations and subsequent geo-referencing so images can be used for spatial analysis. We coupled low-cost GPS loggers to track aircraft/camera position, altitude, and bearing with high spatial/temporal accuracy, and computer software to automatically provide rough geo-positioning of collected images. A Canon XSi digital camera, synchronized to Universal Time by photographing the US Naval Observatory's Master Clock webpage is mounted pointed vertically downward in the belly of an aircraft. Our program takes the time when the image was taken, finds the position and elevation of the aircraft, rotates the image to account for aircraft direction, and rough positions the images automatically based on lens characteristics and height above the ground. The process creates a world file which provides coordinate and scale information and a projection file that specifies the geographic projection and datum used. Our algorithm can be used to batch process files leading to extremely fast coarse geo-referencing of aerial photos which were generally accurate to 100 meters when tested at 5 locations in Oregon. This is close enough to make further correction, if needed, quick and easy.

0237

Feature Mapping on Extensive Landscapes Using GPS-Enabled Computers

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Landscapes in the western United States are vast yet managers are called upon to know them intimately so they can respond to natural events such as fire, insect outbreaks, and invasive species and anthropogenic disturbance. These landscapes are not static and naturally change with season and ecosystem succession or retrogression. To better understand dynamic landscapes, managers have relied heavily on USGS quadrangles and aerial/satellite imagery, often heavily annotating paper maps. Because so many maps, images and databases are now available in digital format, we have begun using full-feature GIS software on GPS-enabled laptops. Laptop systems are preloaded with Digital Elevation Models, Digital Raster Graphics, Digital Orthophotographic Quadrangles, NAIP imagery, digital vegetative maps, and other spatial data covering the area of interest. When we go to the field, the GPS finds our location and shows it on the computer screen along with whichever background information we choose; traditional map or aerial images. In addition to the benefit of knowing where we are on the map, we can also digitize feature points, lines or polygons and save them to the database. Collected digital information such as photographs, sound files, and notes can be tagged to specific locations. We have found real-time, mobile, field-based, GIS useful for mapping vegetation and weeds, wildlife survey, stream and spring mapping and for updating older digital databases. This technology is adaptable to fixed-wing aircraft, helicopters, trucks and all-terrain vehicles. Mobile GIS mapping directly to the computer is an innovation that we find saves us time and money.

0238

Identification of Plant Functional Groups as Indicators of Ecological Condition in Wet Meadows (Lentic Sites) of the Sierra Nevada, California

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An objective for management of mountain meadows is healthy plant communities that function properly while meeting objectives of resource managers such as wildlife habitat, healthy streams, forage for livestock, resilience to weed infestation, water yield from mountain watersheds, and biological diversity to name a few. Functional classification of the diverse plant species that occur in meadows provides a means to assess the condition of these meadows. In this study, wet meadows (lentic sites) in the montane zone of the Sierra Nevada, CA were sampled that ranged from degraded to little disturbed. The meadow plants were categorized (including 198 meadow species) into three primary functional groups, ruderals, matrix and interstitial species which we subdivided into a total of eight species guilds. The functional classification obtained is consistent with Boutin and Keddy's model for wetlands. These functional groups were identified using CCA (Canonical Correspondence Analysis) and two-way indicator species analysis (TWINSpan) according to seven functional traits: life span, life form, dispersal mechanism, potential height, root morphology, root length density, and N-fixation. The matrix functional group which included tall, clonal, deep-rooted sedges was more abundant in the less disturbed meadows. The ruderal functional group which included short, annual or perennial, tap-rooted forbs was more abundant in the highly disturbed meadows.

0239

Very-High Resolution Image Registration and Mosaic Creation

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Remote sensing of the environment can be successfully done from low altitude aircraft using inexpensive camera equipment. However, there are several challenges to surmount to create a product of good scientific quality. Large survey spaces must be covered by many photographs that can be assembled into mosaics. Geo-registration error, terrain parallax, and sun-object-camera scattering geometry all contribute to create apparent tile boundary errors in mosaics. The variation of scattering geometry across the mosaic and across individual photographs, in particular, renders such mosaics difficult to interpret relative to satellite data for which the scattering geometry is effectively constant. This paper discusses technology that is being commercially employed by Falcon Scan today to overcome these challenges. The Falcon Scan technology produces giga-pixel NIR and visible mosaics at resolutions from 10cm to 1m, with one meter geo-registration errors. Deeply layering such mosaics enables multiple look angles to common ground sites to be represented in the dataset, and reflectance to be modeled as a function of scattering geometry. The latter potentially unlocks new information for classification and analysis.

0240

Alternative Uses of CRP Lands: The Use of Livestock Grazing to Enhance Vegetation and Wildlife Biodiversity

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The Conservation Reserve Program was designed to protect natural resources by creating perennial vegetation on marginal, at risk, farm land that demonstrated high potential for erosion and, as a result, sedimentation of our nation's water. While habitat for wildlife is mentioned as a priority, management of these lands in the past 25 years has not focused on wildlife or vegetation diversity. This paper will discuss the use of livestock grazing to enhance vegetation and wildlife diversity. When cattle grazing is viewed as a "disturbance tool," managers may be able to use grazing to drive vegetation successional change, as well as create habitat for desired, at risk, and/or endangered wildlife species. From Oklahoma to Oregon, recent research has suggested that cattle grazing with the appropriate timing, duration and intensity of use can create habitat diversity for a variety of species. For example, past research has demonstrated that cattle grazing can change the quality and quantity of forage available for big game. In fact, recent research suggests that prior cattle grazing may improve subsequent diets for elk grazing mixed conifer rangelands. Likewise, recent research suggests that beef cattle dietary preferences can be compatible with long-term vegetation needs of big game populations. Likewise, recent research in Oregon has suggested that insect and ground nesting bird biodiversity is modified by beef cattle grazing with nonuse and excessively high use corresponding to the lowest diversity estimates. Finally, the use of CRP lands to buffer seasonal shortages of livestock forage may help the conservation of all arid Western Rangelands.

0241

Peatlands: Ecology and Conservation

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Peatlands are generally defined as wetlands with waterlogged substrates and an accumulation of organic matter (peat) as a result of incomplete decomposition. Because the rate of peat accumulation exceeds the rate of decomposition in these habitats, they are considered autogenic (self-creating). In the northern Rocky Mountains, peatlands are represented by fens, which are influenced by both precipitation and groundwater (as distinguished from bogs, which receive water input from precipitation only). The two primary types of fens in this region are basin fens (with peat accumulation occurring in shallow to deep pond or lake basins) and flow-through or slope fens (with peat accumulating on gently sloping terrain). Bedrock geology strongly influences the chemistry and nutrient status of fens that develop in a particular area. Well-developed fens are uncommon in the northern Rocky Mountains, and are occupied by a large number of rare plant species and communities. Because they are influenced by groundwater derived from larger landscapes, fens are susceptible to land uses in surrounding areas. Conservation of these habitats thus depends on sound management of both the fens and the adjacent uplands.

0242

Rainfall Interception and Partitioning by *Pinus monophylla* and *Juniperus osteosperma*

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This study investigated canopy interception of simulated rainfall by singleleaf piñon (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) in central Nevada. Research has shown that although piñon and juniper occurred historically throughout the western United States, the infilling of woodlands and expansion into sagebrush steppe has caused a degradation of understory vegetation communities leading to increased surface runoff and soil erosion. We hypothesize that canopy interception of rainfall plays a significant role in the degradation of understory plant communities by reducing available soil water. For our study, four storm sizes 2.5, 7.6, 12.7 and 19.1 mm were applied to trees of various sizes. Interception was quantified using total precipitation applied minus stemflow and throughfall. Results of this study indicate that singleleaf piñon and Utah juniper partition throughfall and stemflow differently. Additionally, the most typical central Nevada rainfall event of 2.5 mm was almost entirely absorbed by the tree canopy. These results show canopy interception is a critical part of piñon and juniper's ability to dominate site resources. Analysis of Variance will be used to partition differences between species and storm sizes. A predictive model, determined through regression analysis, of interception as a function of tree species and allometrics is currently being developed. Results will be presented.

0243

Estimating the Cost of Replacing Forage Losses on California Annual Rangeland

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Valuable forage is often lost on annual rangelands because of wildfires, cultivation, road construction, and excavation. Estimating the cost of such losses cannot be based upon traditional grazing rental rates for livestock because the impact on forage production is more far reaching than the impact of grazing. All residual dry matter is removed and, except in the case of fire, the soil profile is disturbed. In addition to the loss of current year's forage, forage production, length of adequate forage-growing periods, and species composition are affected for the next two years. Information is readily available through the Natural Resource Conservation Service (NRCS) to estimate normal production through Soil Survey data or Ecological Site Descriptions. Data from UCCE research documents forage reductions the first and second growing season after fire. This data and data from NRCS, is integrated to provide a data based procedure to determine the financial cost of replacing loss forage. An Excel® spreadsheet was created to be layman friendly, needing only basic information to be entered, such as normal production data, and acres affected within different range sites. Calculations are based on up-to-date residual dry matter estimates, utilization estimates adjusted for slope and range type. Total tons of forage lost in the effected area over the ensuing three years is calculated. By entering an appropriate dollar value for replacement feed per ton delivered, a total dollar value is calculated for purchasing and feeding replacement feed. Utilizing data based procedures reduces probability of over or under estimating losses.

0244

Plant Materials Development in the Southern Rocky Mountains

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The development of native plant materials has historically followed a systematic process where testing of multiple collections or accessions of a given species at multiple locations has been the driving force for selection and release. However, resource needs of various land management agencies coupled with concerns of long term genetic alteration of indigenous populations has led to the production of many source specific products that are largely untested. Observed phenotypic attributes of a given accession or release are sometimes deemed less important than origin of source. The complexities involved in native plant material development require the right match of product growth and expansion to fit customer needs. The success of the development process is tied directly to initial planning between the developing party and the end user. The benefits and shortcomings of four different native plant material development processes that are currently being conducted at the Upper Colorado Environmental Plant Center are presented.

0245

Ten Year Assessment of a Tebuthiuron Treatment of Shinnery Oak to Enhance Grassland in Eastern New Mexico: What Did We Learn?

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During September, 2000, pre-treatment vegetative surveys were conducted in Southeastern New Mexico on both the Weaver Ranch (treatment area) and the adjacent North Bluit Prairie Chicken Area (control area) owned by the New Mexico Department of Game and Fish to determine if differences existed in the vegetative composition of the two land parcels. No significant differences were observed. During October, 2000, tebuthiuron was applied to approximately 1600 ha of the Weaver Ranch at the rate of .66 kg/ha (0.6 of the labeled rate) to suppress shinnery oak (*Quercus harvardii*) and restore grasses to their former dominance. No tebuthiuron was applied to the dune areas that were historically dominated by dense shinnery oak mottes. Following the treatment there was a reduction in shrub occurrence, specifically shinnery oak, and a corresponding increase in grass occurrence. The increase in grass occurrence was primarily a result of the expansion of grasses present before the treatment. Soil moisture has been higher on treated than non-treated areas each time soil moisture was measured. Forb occurrence and diversity has consistently been greater on treated than non-treated areas after year one. The resultant landscape is a mosaic of grasslands and shinnery oak, similar to historic conditions. Following treatment, the treated area produced more forage, grass seed and forbs than did the control area and forage quality was similar on both areas. Lesser Prairie Chickens have nested and reared broods successfully on treated area and been observed on all treatment areas during all periods of the year.

0246

Preliminary Results for Rapid Determination of Sagebrush Using DNA Recovered from Cattle Feces

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We designed a feeding trial in order to validate the sensitivity of sagebrush detection in hand-fed diets of known composition by using DNA analysis. Five crossbred steers fitted with a permanent ruminal cannula were used in a replicated 5 x 5 latin square with 21-d periods. Dietary treatments consisted of different hay:sagebrush ratios (% DM base): 100:0; 99.5:0.5; 99: 1; 97:3; and 91:9. Sagebrush leaves and mineral and vitamin supplements were mixed with the rumen content and fed immediately before all animals received hay. This was done to ensure that steers had only two different plant-family components in the diet. Total DNA was extracted from about 100 mg of dried feces. Shorter, multiple copy sequences from the chloroplast genome that survived digestion were successfully amplified and differentiated based on its length and Guanine and Cytosine content. The melting profile of sagebrush PCR products were used for DNA sequence matching utilizing saturating dyes that fluoresce in the presence of double-stranded DNA. This technique distinguished samples with 100% accuracy. Results returned perfect matches with the respective controls in diets containing sagebrush. The DNA melting profile makes possible to quickly and accurately determine whether DNA sequences match, providing a useful option for studying plant animal interactions. In conclusion, we present a novel and robust approach to characterize mixed and highly degraded DNA samples such as those often-encountered in ecological studies. As this is a proof of concept study, more work will be done to further test the limits of the procedure.

0247

Assessment and Demonstration of Ecologically-Based Medusahead and Cheatgrass Management in Jordan Valley, Oregon

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Medusahead was first noted in Jordan Valley, OR approximately 25-30 years ago. It has significantly expanded within the last 10-20 years. As part of the USDA-ARS Area-wide project for invasive annual grasses, landscape scale demonstration plots were established with five cooperating ranches in 2008 with the objective to demonstrate the potential of using the single-entry (one-pass herbicide/seed application) strategy to rehabilitate annual-grass infested rangelands across large heterogeneous landscapes and determine those abiotic and biotic factors that are most important in influencing the success and/or failure of the rehabilitation effort. Treatments included one-pass imazapic application and seeding, imazapic only, seeding only and a control. Imazapic was applied at 3.5 oz/ acre and the seeding mix was crested wheatgrass and Sandberg's bluegrass at 20 lbs/ acre. Seedling establishment was unsuccessful in 2008 and treatments were reapplied in fall of 2009. Initial data collected in June 2010 indicates that seedling establishment was more successful.

0248

***Artemisia* Population Dynamics Under Different Climate Change Scenarios**

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This study will examine *Artemisia tridentata* spp. *tridentata* population dynamics across an elevational gradient from the high Sierra where the plant is at its physiological limit to the heart of its range in the western Great Basin. We will include a treatment at each site in which we manipulate snowfall totals using snow fences to create zones of increased and decreased, as well as, ambient snow accumulation to make predictions about how *A. t. tridentata* populations will respond to climate change. We will use matrix projection models to describe the growth rate of each population x snowfall treatment and elasticity analyses to quantify the importance of each vital rate to population growth. These analyses will also allow us to determine if *A. t. tridentata* populations are behaving differently across the elevational range and how changes in snowfall totals might affect each differently.

0249

Role of Fire and Grazing in Conserving Grassland and Shrubland Birds in the Southern Great Plains

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Grassland bird populations as well as some shrubland bird populations have experienced some of the greatest declines of any North American bird guilds, with the predominant cause of these declines being extensive loss and degradation of native grassland and shrubland ecosystems. Traditional rangeland management practices based on the paradigm of increasing and sustaining livestock production through reducing the inherent and disturbance-driven variability that historically occurred in grasslands and shrublands have also contributed to the declines of these birds. An alternative approach to this homogeneous management paradigm is an approach that attempts to restore a shifting mosaic of disturbance patches across the landscape through the spatial and temporal interaction of fire and grazing (i.e., pyric herbivory). Application of pyric herbivory increases overall habitat heterogeneity of grassland and shrubland ecosystems which is likely a critical factor in maintaining and enhancing grassland and shrubland bird populations. In this paper, I describe the responses of grassland and shrubland birds to pyric herbivory in a tallgrass prairie and a sand sagebrush (*Artemisia filifolium*) ecosystem in Oklahoma and discuss the implications of pyric herbivory for conserving these imperiled bird species.

0250

Monitoring of Livestock Grazing Effects on Bureau of Land Management Land

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Public land management agencies, such as the Bureau of Land Management (BLM), are charged with managing lands throughout the western U.S. for multiple uses including livestock grazing and conservation of sensitive species and their habitats. Effective management of these multi-use landscapes may be aided by data and information on the condition and trends of these rangelands, particularly with respect to effects of livestock grazing. We therefore investigated the availability of BLM livestock-related monitoring data and the status of Land Health Standards across the region and then sought input from university and federal rangeland scientists about how best to prioritize rangeland monitoring activities. Our preliminary findings show that monitoring data most commonly existed for actual use (permittee-reported livestock numbers and season-of-use), followed by permanent photo point, forage utilization, and finally, vegetation trend measurements. Preliminary analyses of the BLM's Land Health Standards data indicated that BLM found 67% of allotments to be meeting standards. For those not meeting standards, livestock were considered the causal factor in 45% of cases (about 15% of all allotments). Our data inspections, as well as conversations with BLM personnel, indicated a need for greater emphasis on collection of grazing-related monitoring data. We highlight commonalities between BLM monitoring approaches and rangeland scientist suggestions, present ideas for making the most of existing historical data, and finally discuss emerging ideas for rangeland monitoring.

0251

Water Requirements of Common Plant Species in the Owens Valley, CA

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This study addressed the issue of how much water is required for above-ground biomass production of important plant species in the Owens Valley, CA. Plants were grown in the field as a garden study in 2.4 m x 2.4 m plots and irrigated at different monthly rates: low (12 mm), middle (25 mm), and high (37 mm) during 2009 and 2010. In general, higher irrigation rates produced higher biomass, but for the three grasses investigated (*Distichlis spicata*, *Leymus triticoides* and *Sporobolus airoides*) the low and middle irrigation levels did not produce significant differences in biomass production. Throughout the spring and summer of 2009 *S. airoides* was the most efficient grass; it required about 3.5 liters of water to produce one gram of biomass. In the same period of time, water requirements of *D. spicata* and *L. triticoides* were 2.6 and 9.5 times larger than those of *S. airoides*. Water requirements were lower in shrubs than in grasses; *Artemisia tridentata* was the most efficient shrub with 1.2 liters of water used per gram of biomass produced. However, water requirements at the onset of the spring season in 2010 were much lower than during the spring-summer of 2009: *S. airoides* required 0.6 liters to produce one gram of biomass while *D. spicata* and *L. triticoides* required 0.9 liters. Water requirements included evaporation and transpiration losses and adjustments for ground cover need to be considered. Results can be used to better estimate water usage of the different types of vegetation in Owens Valley.

0252

The Economic Consequences of Ecological Thresholds: An Application to Ranching in the Great Basin

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The spread of invasive annual grasses and the resulting increase in the frequency and severity of wildfires pose a significant threat to the ecology and rangeland-based economy of the Great Basin. Adding to the urgency of the problem is the fact that in many circumstances the conversion of rangeland to annual grasses is either impossible or prohibitively expensive to reverse. Given the presence of these irreversible thresholds, resilience becomes an important property of the ecosystem, where resilience is defined the ability of the ecosystem to recover from a disturbance (e.g., wildfire, overgrazing). In this paper we construct a bio-economic model of rancher decision making that is subject to the dynamics of herd-size adjustments, wildfire fuels accumulation, and probabilistic transition between ecological states. We use this model to analyze how the presence of irreversible ecological thresholds and stochastic wildfire influence a calf-cow producer's herd management and fuels treatment decisions.

0253

Rodents as Agents of Ecological Change

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Rodents have the potential to exert a wide array of ecological pressures in any given ecosystem. The negative impacts to plant communities in general, especially cultivated crops, are typically cited as examples of rodent grazing pressure. Indeed, calculable economic damage can be inflicted, especially during cyclic population highs. Considerable research has been conducted on the negative impacts of prairie dogs, ground squirrels, and pocket gophers in particular. On the positive side, and often ignored, are the ecological benefits that rodents provide. Even the group of species described above can impact rangelands positively, by decreasing soil compaction and increasing soil aeration, fertility, and water-holding capacity. Rodents also transport mycorrhizae associated with range plants and therefore can potentially establish plant species and their mycorrhizae on denuded range sites. Many species of desert rodents disperse seeds, and the seed caches of these rodents are a major source of plant recruitment. This is especially true for unrecovered caches because seeds left in shallow subsurface caches are in a favorable environment for germination and early seedling survival. For example, kangaroo rats are the key to the establishment of Indian ricegrass, a desirable perennial species. Research by the authors has shown that this native grass requires manipulation and caching by these rodents to ensure germination and ultimately the maintenance of Indian ricegrass stands. Seed germination is greatly enhanced by the rodents' removal of seed coverings (lemma, palea, and pericarp) that induce dormancy. Emergence of seedlings from rodent caches is the primary means of ricegrass stand renewal.

0254

Using Small Unmanned Aerial Systems to Collect High Resolution Imagery for Site Specific Land Management Applications

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The United States Forest Service (FS) is looking at Unmanned Aerial Systems (UAS) to augment our current manned platforms in niche applications that suit the attributes of UAS platforms. While most of our focus is on wildland fire support missions it is apparent that small UAS can be used to collect high resolution imagery for site specific land management applications including Forest Inventory and Analysis plot locations, timber sales, rangeland, and law enforcement applications. Traditionally, the FS has used manned aircraft to collect this imagery. While effective, it is costly and at times logistically difficult if the project area is relatively small. Several pilot projects conducted by the FS have shown that small UAS are able to acquire imagery over plots autonomously, and that the image quality is equal to traditional methods. Near term developments in aviation regulations will allow researchers and land managers to conduct site specific surveys quickly and efficiently.

0255

Digital Charting Technologies and their Applications on Rangelands

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Airborne and satellite remote sensing can provide extremely useful information or just pretty pictures. The difference between these two outcomes is due largely to the quality and quantity of ground-truthing data collected to support the remote sensing effort. Collecting an adequate amount of high quality ground-truthing data, however, is difficult and very expensive using traditional field techniques. We developed a ground-based photography system for "digitally charting" vegetation characteristics by acquiring geocoded, nadir imagery with a typical field plot-sized, 1-m² footprint and sub-millimeter ground sample distance (GSD). This system consists primarily of off-the-shelf components including a consumer-grade digital camera, monopod and head, GPS logger kit, compass, and bulls-eye level. We also developed custom software to support the photography system. GeoAlbum compiles, scales, and geocodes raw imagery while VegMeasure2 performs several innovative image classification analyses optimized for near-earth photography. Use of digital charting technologies allow rapid ground-truth sampling of vegetation cover, plant density, and species frequency for hundreds of plot areas per day across extensive landscapes. Digital charting thus reduces the large field personnel requirements typical of traditional ground-truthing campaigns. Use of these technologies also shifts the time costs of ground-truthing from the field to the office where image processing and analysis tasks can be conducted on a schedule not dictated by field conditions. Combined, the advantages of digital charting make rigorous ground-truthing possible where it was previously cost-prohibitive.

0256

Range Camp on the Western Fringe - California-Pacific Section

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The California-Pacific Section's Range Camp is a 27-year institution on the West Coast. It began in 1985, initiated by section members who were staff of the US Navy's Naval Facilities Engineering Command, Cooperative Extension, federal agencies (SCS, USFS), and in private business (ranching, consulting). The week-long experience in natural resource science and management continues to be a well-coordinated activity with support of many partners brought together within the section. This poster will focus on developments over the camp's history, present learning objectives and assessment methods, its curriculum and activities, and the primary challenges the camp staff and steering committee are presently addressing (increasing student numbers; improving outreach to tribal youth, urban youth, and under-served rural areas; managing and developing sponsors).

0257

Use and Effectiveness of VLSA Imagery for Invasive Weed Monitoring in Rangelands

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Spatial monitoring of weed infestations is important for studying and managing invasive weeds in rangelands. Tools such as very large scale aerial (VLSA) imagery have the potential to increase the efficiency of data collection by allowing users to assess a large area quickly. Here we discuss the use of VLSA imagery for collecting data on two morphologically distinct weed species, Dalmatian toadflax (*Linaria dalmatica*) and downy brome (*Bromus tectorum*, cheatgrass), in rangeland plant communities. Aerial cover determined from VLSA imagery was highly correlated ($R^2 = 0.94$) with aboveground phytomass of Dalmatian toadflax. VLSA was also useful in documenting post-fire population changes of downy brome at high elevations. Time expended acquiring data from images is directly related to the complexity of information needs, i.e. presence/absence is more quickly ascertained than aerial cover by species. Image quality has improved from earlier data collections (circa 2003), thereby enhancing our ability to determine target species. Aerial imagery provides weed managers the opportunity to expand their search for new weed infestations into remote areas with limited vehicular access. Effectiveness of current-generation VLSA imagery for management of invasive weed populations is restricted by incomplete coverage and scale of observation, which limit its utility as a comprehensive survey and mapping tool. However, it is useful for research that requires rapid, quantitative measurements of plant species richness or cover. As technology continues to improve, the logical progression from VLSA imagery meeting the needs of weed researchers to providing useful information for weed managers is likely.

0258

Forecasting Annual Aboveground Net Primary Production in the Intermountain West

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For many land managers annual aboveground net primary production, or plant growth, is a key factor affecting business success, profitability and each land manager's ability to successfully meet land management objectives. The strategy often utilized for forecasting plant growth is to assume every year is an average year and make changes and adjustments to management as needed. This strategy leaves little time or opportunity for land managers to plan ahead and prepare for below average years, or take advantage of above average years. This study tested the accuracy of plant growth forecasts from two computer models: Agricultural Land Management Alternatives with Numerical Assessment Criteria (ALMANAC) and the Soil Ecohydrology Model (SEM). ALMANAC is a physiologically based crop production model designed to quantify key plant-environment interactions that influence productivity. SEM is a capacitance parameter model that uses a water-balance approach to simulate soil moisture and the DeWitt equation to forecast yield. Model forecasts of plant growth were compared to field collected yield data. Preliminary results indicate that ALMANAC forecasts provide reasonably accurate yield numbers when input criteria are properly calibrated for each site while SEM forecasts are not consistently accurate. A special emphasis was placed on soil moisture expressed as volumetric water content as a model calibration tool. Both ALMANAC and SEM forecast soil moisture as a part of the plant growth forecasting process. Soil moisture was chosen over other variables that affect plant growth because it is a direct way to measure plant available water, a common plant growth limiting factor.

0259

GIS Tools, Courses, and Learning Pathways Offered by The National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT)

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Technological advances in the area of fuel and wildland fire management have created a need for decision support tools and effective training in the use of these tools and technologies. The National Interagency Fuels Coordination Group has chartered a team of professionals to develop science-based fire and fuels assessment tools, and to provide online training and technology transfer, to help managers implement fuels, fire, and vegetation management technology for fire risk mitigation and ecosystem restoration. The team is called the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT). NIFTT has created and maintains seven GIS tools and has developed user resources for these tools, including user's guides and tutorials. The learning tools include the Fire Regime Condition Class Mapping Tool, First Order Fire Effects Model Mapping Tool, LANDFIRE Data Access Tool, Area Change Tool, and the Fire Behavior Assessment Tool. NIFTT offers several online courses that facilitate the learning and implementation of these tools, in addition to courses focusing on fuels and fire related topics in forests and rangelands. Six courses are currently available, with several more in development. To assist independent student learning, NIFTT has developed "Learning Pathways" that provide easy-access to related learning materials in an order designed for optimal learning efficiency, currently featuring the concepts of fire behavior, fire effects, and fire regimes. Additional information and registration for these courses and detailed descriptions of the Learning Pathways are available at www.nifftt.gov. This poster will provide information on the available NIFTT learning tools, courses, and learning pathways.

0260

Comparing Methods of Rangeland Measurements: Proper Design and Statistical Analysis

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Rangeland scientists and managers have interest in adopting new, more efficient, rangeland sampling methods, but, before new methods are adopted, they should be validated. Within the range science literature, there is no standard for conducting method comparison experiments and reporting the results. Approaches vary from correlation, paired t-tests, and regression analysis. Often, the results are ambiguous as to how well the new method agrees with an established method. The primary aim of a method comparison study is to determine whether the new method agrees with a conventional method sufficiently to be used interchangeably. The objective of this paper is to: 1) introduce the Bland and Altman approach to the method comparison problem, 2) demonstrate limitations of other approaches, and 3) suggest reporting standards that addresses how well a new method agrees with established methods. Example datasets were used to demonstrate the analysis and which results should be part of a standard report. The analysis and reporting standards are borrowed from the medical literature where establishment of method comparison standards are gaining prominence. By adopting these methods and reporting standards the validity of new methods will be communicated with greater clarity.

0261

Assessing Sagebrush Steppe Rangelands with VLSA Imagery

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Many conventional rangeland sampling methods are inefficient and have precluded rangeland managers from obtaining statistically adequate samples that are needed to guide rangeland management. Very large scale aerial (VLSA) photography is a remote sensing method that is useful and cost effective. We present uses of VLSA imagery in sagebrush steppe, describe some of its limitations, and suggest some remaining research questions. Our first experiments were designed to compare VLSA measurements of bitterbrush, horsebrush, and sagebrush cover with ground-based measurements. Methods were developed to georeference imagery and determine aircraft-based location error rates and to ensure that paired comparisons were made. Experiments were conducted to determine relationships between time since last burn (TSLB) and bitterbrush, horsebrush, and sagebrush cover. Studies have been conducted to measure invasive weed and non-native plant density and cover. Currently, experiments are being conducted to validate herbaceous cover measurements from various height and lens focal length configurations. For bitterbrush, horsebrush, sagebrush and shrub cover, agreement between methods was equal to ground-based method repeatability. VLSA imagery is a suitable method for sampling large areas, but image placement is not sufficiently accurate to efficiently acquire repeat imagery of small plots, especially for small 4 m by 3 m field of view VLSA images. VLSA imagery provides much detail about plant communities that other remote sensing methods lack, while remaining cost effective. Methods that use VLSA imagery are likely to play an important role in helping rangeland managers and scientists obtain useful measurements on sagebrush steppe rangeland in the future.

0262

Changes in Relic Plant Communities in Utah over 60 Years

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During the 50's and 60's, the USDA SCS employees H.B Passey and Vern K. Hugie, Range Conservationist and Soil Scientist, worked together to locate and record relic vegetation communities in the sagebrush steppe region of Utah, Idaho, Nevada and Wyoming. Recently discovered records of several of their sites in Utah including original photography were used to attempt to re-locate their sites and repeat the data collection they undertook in order to make comparisons and detect changes that have taken place on these plant communities during the past 60 years. Several of the sites remain relatively unchanged, while others have undergone drastic changes.

0263

Resource Monitoring Challenges and Technological Needs for the BLM

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The Bureau of Land Management is facing monitoring challenges including reduced budgets and staffing, more complex workloads, methods challenged in courts, and a responsibility to report on public rangeland condition. Effective strategies on why, what, and how we monitor are critical. Accurate, repetitive, and credible monitoring data, together with the application of statistical science for testing the questions for which data are collected, are fundamental to making court-defendable management decisions. The BLM collects a significant amount of data on paper annually that is driven by permits and projects. The use of remote sensing data and technologies will be a vital component for the BLM's monitoring programs for permits and projects and for eco-regional assessments, aquatic and riparian resources, disturbances and treatment effectiveness at multiple scales, and vegetation occurrence, condition and trend across scales. Challenges for remote sensing include: 1) refine tools to interpret remotely sensed data- need accuracy for on-the-ground management, 2) insufficient classes of land cover for shrub and grasslands, 3) expand dialogue between remote sensing community and land managers about remote-sensing detectable land-health indicators, and 4) institutionalize use of remotely sensed data into ongoing monitoring programs. One approach BLM developed to address the challenge is the AIM (Assessment, Inventory and Monitoring) Strategy. Preliminary results of the AIM Strategy has determined a need to: 1) improve land cover mapping through Landfire as a land use planning tool, 2) inventory springs and springbrooks in riparian/aquatic environments, and 3) integrate monitoring imagery to measure cover, bare ground, composition and intercanopy gaps.

0264

Evaluation and Use of Sunn Hemp (*Crotalaria juncea* L.) at the Manhattan Plant Materials Center (PMC), Manhattan, Kansas

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Sunn hemp (*Crotalaria juncea* L.) is an annual tropical legume that was identified in the 1930's as a green manure and cover crop. Sunn hemp is very sensitive to frost and does not produce seed above 28 degrees north latitude; therefore, it has little potential to become a weed problem in the continental U.S. Until recently, sunn hemp has not been an ideal forage for livestock because it contains high levels of poisonous alkaloids. The variety 'Tropic Sun', released cooperatively by the University of Hawaii and the U.S. Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS) Ho'olehua Hawaii Plant Materials Center, produces very low amounts of alkaloids, making sunn hemp a viable option for livestock forage, and giving it potential for use as a cover crop that can also be grazed. Studies have been initiated at the PMC to evaluate sunn hemp. Plantings using different seeding rates and different planting dates were established and measures of above ground biomass, forage quality, photosynthetically active radiation (PAR) through the canopy, germination percentages, and frost dates were recorded. During the 2009 growing season, 30 days after planting, mean plant height was 7.7 inches and above-ground biomass ranged from 155 to 413 pounds per acre. At 60 days after planting mean plant height was 70.7 inches and above-ground biomass ranged from 1.8 to 4.3 tons per acre.

0265

Establishment and Persistence of Native Grass in Wyoming's High Desert

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There is a critical need to identify native grass species that establish well and persist on disturbed sites on sagebrush-steppe communities important to wildlife such as mule deer, antelope and sage-grouse. Our objectives were to compare the establishment and persistence of grass accessions and cultivars native to the Rocky Mountain region. In October 2005, 32 entries of 15 native grass species were drill-seeded in single-species plots in a randomized complete block design with four replications on a reclaimed well-pad site near Pinedale, Wyoming. Plant density and height were recorded in each of the 5 years post-seeding, whereas biomass sampling began in 2008. Analysis of variance indicated plant counts depended on seeded entries. In 2010, plant densities of 'Sodar' streambank wheatgrass (46 plants/m²) were greater than all other grasses. Densities of the other top performers were 'Critana' thickspike wheatgrass (31 plants/m²), P-24 bluebunch wheatgrass and L-46 basin wildrye (26 plants/m²), 'Rodan' western wheatgrass and Washoe basin wildrye (22 plants/m²), 'Trailhead' basin wildrye (18 plants/m²), and Salina wildrye and 'Continental' basin wildrye (17 plants/m²). In general, rhizomatous grass densities increased over time while densities of bunchgrasses remained constant or decreased. Mean plant height was species-specific, with basin wildrye exceeding 84 cm, while Sandberg bluegrass, bottlebrush squirreltail, and Indian ricegrass were 13 cm. The demonstration planting indicates there is great need to improve availability of adapted forb species. Results suggest currently selected plant materials provide good options to restore disturbance, improve soil stability, contribute to ecosystem function, and enhance wildlife habitat.

0266

Comparing Seed Mixes and Seeding Techniques for Restoring Plant Communities in Wyoming's High Desert

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There is a need to restore native plant communities critical to wildlife habitat on Wyoming's high elevation sagebrush steppe disturbed by development. This demonstration addressed two important factors influencing plant community establishment: species selection and seed placement. Species selection was examined using two seed mixtures - one with a high proportion of shrub (36% grasses, 13% forbs, and 53% shrubs) and the other with a high proportion of grass (72% grasses, 23% forbs, and 5% shrubs). Seed placement was examined by seeding method - drilled or broadcast. Treatments were evaluated by counting plants per species within 20, randomly placed, 0.89 m² hoops, in the 0.2 ha broadcast and in the 0.41 ha drill plots. After five years, composition in the shrub mix was 72% grass and 28% shrubs, with less than 1% forbs where seeds were broadcast; and 64% grass and 36% shrubs, with less than 1% forbs where seeds were drilled. Community composition of the grass mix was 91% grass, 2% forbs, and 7% shrubs where seeds were broadcast; and 95% grass, 2% forbs, and 3% shrubs where seeds were drilled. Where the shrub mix was broadcast, the small-seeded *Poa secunda* was the predominant grass, while large-seeded grasses were most common where the grass mix was drilled. The demonstration planting indicates there is great need to improve availability of adapted forb species. Our observations suggest plant community development can be enhanced by increasing seed density and percentage composition of desired species and using seeding methods that optimize seed placement to facilitate germination and establishment.

0267

Nutritional Composition of *Carex sprengei* in North Dakota

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While developing an ecological site description for the riparian ecosystems of the Middle Sheyenne River in eastern North Dakota, we found *Carex sprengei* to be the dominant understory forage species in shrub and woodland communities, accounting for up to 95% of the understory production. In 2009, research was established to study the nutritional status of *Carex sprengei*. *Carex sprengei* plants were collected every two weeks beginning in mid-May when riparian sites became accessible and continuing until fall freeze up, which was mid-October in 2009. Five samples were collected at two sites, a grazed and ungrazed site. Plant tissue was analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), in-vitro dry matter digestibility (IVDMD), calcium, and phosphorus. CP and IVDMD were highest in May and reduced throughout the growing season at both the grazed and ungrazed clipping locations, while ADF and NDF were lowest in May and increased throughout the growing season at both locations. Calcium and phosphorus remained constant throughout the growing season at 0.43-0.65% and 0.19-0.41%, respectively. The CP content ranged from 24% in May, 13.9-17.3% in June, 12.2-15.8% in July, 13% in August, 12.2-13.3% in September, and 11.7-12.5% in October. IVDMD content ranged from 80% in May to 40.2-44.4% in October. ADF content was between 19.4% and 22.1% in May and increased to between 32 and 33.8% in October. NDF content was 44.5-46% in May, increasing to 62.3-63.1% in October. There were no differences in nutritional composition between the grazed and ungrazed clipping locations.

0268

Effects of Prescribed Burning and Litter Type on Litter Decomposition and Nutrient Release in Mixed-Grass Prairie in Eastern Montana

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Fire can affect litter decomposition and carbon (C) and nitrogen (N) dynamics. Here, we examined the effect of summer fire and three litter types on litter decomposition and litter C and N dynamics in a northern mixed-grass prairie over a 24 month period starting ca. 14 months after fire. Over all sampling dates, decomposition and nutrient mineralization (C and N) rate constants varied by litter type (alfalfa > grassland > straw) and burning treatment (burn > unburned). Litter type explained most of the variation and corresponded with differences in: C:N, % C and N, and total C and N. Over the entire study, burning had a significant but relatively small effect on decomposition rate constants. This single estimate of decomposition; however, masks temporal variation among treatments. Initially (0 to 12 months) litter decomposed slower in burned than in unburned plots and may affect how litter pools are restored. This relationship reversed from 12 to 24 months. Litter in burned plots also had lower total C and N and % C and N between 6 to 24 months suggesting a transformation in litter chemistry during the first 6 months of the study which then persisted. Decomposition in recovering burned plots lagged behind those in unburned plots but functioning appeared to be restored after ca. 2.5 years post-fire.

0269

Development of a State-and-Transition Model for the Middle Sheyenne River

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The geology of the Middle Sheyenne River Valley located within Eddy and Nelson Counties in Eastern North Dakota is dominated by alluvial terraces and flood plains, characteristic of valley type VIII as described by Rosgen. Valley type VIII supports stream types C, D, E, F, and G. Nine cross-sections were sampled to identify stream type using Rosgen's classification of natural rivers. Classification of these cross-sections resulted in eight C5/6 and one E5/6 channels. The results of our stream classification lead us to conclude that stream type succession scenario one is most appropriate for the Middle Sheyenne River. In scenario one, the stable reference reach is an E channel, when stability is lost it first becomes a C channel, which is transformed into a Gc channel, followed by an F channel, as it begins to stabilize it becomes an entrenched C channel, and finally it becomes an entrenched E channel. In the state-and-transition model the E and C channels, the potential natural channels, make up state one. State two is comprised of the Gc and F channels, which are unstable as the stream is actively downcutting and widening. State three is comprised of the entrenched C and E channels that have restabilized forming a stable analog. We identified five major community components including; 1) the greenline, 2) a forested community, 3) a shrub community, 4) a grassland community, and 5) a wetland component. The proportion and composition of community components is subject to alterations in channel morphology and management.

0270

Regional Research and Management: Sagebrush Steppe Treatment Evaluation Project

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SageSTEP is a regional research and management project that is monitoring the long-term effects of treatments designed to reduce fuels and restore sagebrush ecosystems in the Great Basin. The project is evaluating the effects of standard fuel management treatments (fire, mechanical thinning, and herbicide) on the recovery of sagebrush ecosystems threatened by cheatgrass invasion and pinyon and juniper tree encroachment. Treatments implemented between 2006 and 2009 are being monitored over gradients of cheatgrass invasion or woodland encroachment at 21 different sites. An inter-disciplinary approach is being used in which nearly 100 variables describing treatment effects on vegetation, soils, wildlife, and fuels will be analyzed to provide information on treatment effectiveness. Project results are being used to develop recommendations and guidelines for fuels management and for maintaining and restoring sagebrush ecosystems. These results also will be useful for landscape-level strategic planning and for understanding the implications of climate change.

0271

Forage Nutrient Availability and Reproductive Success of Semi-Wild Bison in Western Montana, USA

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Conservation concerns have heightened due to sudden declines in calf recruitment rates of approximately 250 American Bison (*Bison bison*) of the pure Pablo herd lineage occupying the National Bison Range (NBR) in Moiese, MT. Understanding bison foraging behavior and habitat selection could provide insight for the dynamic ecological management of the bison and their range. Foraging sites directly selected by bison at the NBR were determined by ocular observations and spatial data collections in an investigation of the Upper Pauline, Alexander Basin, and Mission Creek pastures from June through August 2010. These summer pastures range from riparian to steep topography and contain a variety of landform and vegetation types. All selected sites were assessed to determine dominant plant populations, foraging patterns, and landform utilization. Chemical profiles of forage collections and fecal samples yielded crude protein and digestible energy values available in selected forage. Changes in observable behaviors, forage selection, and grazed stubble height, as well as, declining nutrient availability give evidence to suggest that the forage production of these sites is potentially inadequate to meet the increased energy demands of lactating bison cows. Ensuing nutrient deficiencies impair timely regain of body condition for reproduction in the year following a successful live birth.

0272

Impact of Sheep Grazing on Demographic Parameters of Cheatgrass (*Bromus tectorum*) and Wild Oat (*Avena fatua*) in Three Common Montana Agricultural Systems

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Cheatgrass (*Bromus tectorum*) and wild oat (*Avena fatua*) are problematic weeds in Montana agricultural systems spanning from rangeland to cropland. The primary focus of this project is to investigate how the incorporation of sheep grazing into agricultural systems impacts grassy weeds. Specifically, we evaluated the impact of incorporating sheep grazing into cropping systems on cheatgrass and wild oat populations at a large-scale replicated field experiment located at the Fort Ellis Research Farm near Bozeman, Montana. Demographic parameters including seedbank decay, seedling recruitment, seedling survival, and plant fecundity were obtained in three agricultural systems commonly used in Montana: continuous spring wheat, continuous alfalfa, and a 3-year (wheat, pea-hay barley, summer fallow) rotation. Two sets of paired quadrats were located within each plot and 5,150 seeds/m² cheatgrass and 2,120 seeds/m² wild oat were planted in each quadrat in fall 2009. Rotation plots were subjected to chemical or grazing treatment. Dicamba and/or glyphosate were applied at label rates in summer fallow chemical treatment plots. Stocking rates on summer fallow grazed plots ranged from 134 sheep days/ha to 537 sheep days/ha. Summer fallow plots were treated either two or three times respectively based on weed densities. Weed seedling emergence, survivorship, and seed production were monitored throughout the 2010 season. Preliminary data indicated grazed fallow plots showed 95% less weed biomass when compared to chemical fallow plots. Information gained from this study will be used to build a population growth model allowing producers to incorporate grazing into agricultural management practices.

0273

Rehabilitation of Medusahead and Cheatgrass Dominated Rangelands in the Boise Foothills. An Ecologically-Based Invasive Plant Management (EBIPM) Program Research and Demonstration Project

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The Boise, Idaho foothills have had a long history of human use, are currently grazed by livestock and wildlife, and are a principal area for diverse recreational use. Sagebrush-grass rangelands in the Boise Front have undergone frequent wildfires that have resulted in extensive type conversion to annual grasses, and enhanced risks from catastrophic runoff and erosion. Small-plot treatments are being evaluated on a churning-clay ecological site, currently dominated by medusahead wildrye, to investigate the utility of imazapic (0, 4, 6, 8 oz/ac), prescribed fire, seeding rate (2X, 5X, 10X base rates), and alternative seed mixes (native/non-native) for restoration of these areas. Replicate treatments were applied in the fall of 2008 and 2009 and will be continued for two additional years to evaluate year effects. Landscape scale demonstration plots were treated with 8 oz/ acre imazapic in the fall of 2008 and replicate blocks seeded in mid winter (2010) with a high-rate native or non-native seed mix. In the spring of 2009 and 2010, native shrub seedlings were planted in the area. Initial examination of data found excellent control of medusahead and cheat grass by plateau which varied with application rate and use or non-use of prescribed fire. Initial establishment of planted species was extremely poor across the board in 2008, but significantly improved in 2009.

0274

Mapping Cheatgrass in the Great Basin Using 250-Meter eMODIS NDVI

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Cheatgrass (*Bromus tectorum*) is an invasive annual grass that expanded into the Sagebrush-Steppe communities of the Great Basin and other western United States ecosystems. Historically, periods of multi-year drought resulted in large die-offs of cheatgrass. In recent years, cheatgrass die-off has been documented during non-drought periods and in patterns not easily explained by weather in northern Nevada. Remotely sensed vegetation indices can quantify the abundance and activity of green vegetation, so to map historical cheatgrass extents, we used the enhanced Moderate Resolution Imaging Spectroradiometer (eMODIS) Normalized Difference Vegetation Index (NDVI) at 250-meter spatial resolution. Based on the finding that cheatgrass green-up and senescence periods are distinct from other Great Basin vegetation types, we calculated the difference from integrated spring and summer NDVI values and created annual cheatgrass maps from 2000 to 2010. We compared and contrasted these maps and identified areas where cheatgrass coverage is stable or variable, including areas with increasing cheatgrass dominance or die-off. Die-offs of cheatgrass create large extents of bare ground that can lead to accelerated soil erosion and land degradation, but the phenomenon can also provide opportunities for native grass and shrub restoration. We used 794 random points collected from our 2001 cheatgrass map and Peterson's cheatgrass map to perform a linear regression ($R^2 = 0.65$). Identifying cheatgrass in the Intermountain West enhances predictive models and analytical tools that can help explain causes of cheatgrass die-off, assist in the subsequent development of weather-based predictions of cheatgrass productivity, and inform current and future management of cheatgrass.

0275

Effects of Liquid Smoke on Seed Germination of Shortgrass Prairie Plant Species

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In fire-prone regions, some species may germinate better when receiving fire cues such as smoke and heat. We examined the germination responses of 11 species native to the southern high plains to smoke, heat, and their interaction. Smoke treatments were applied by soaking seeds in 1:5, 1:10, or 1:100 "Regen 2000®" smoke solution for 22 hours. Heat treatments were applied by placing seeds in a warm oven at 50°C or 80°C for 5 minutes. A mix of grasses, forbs, and shrubs were tested. *Salvia reflexa* responded to the 1:10 smoke solution by increasing germination percent ($p < 0.001$). Likewise, *Gutierrezia sarothrae* seeds exposed to the 1:5 smoke solution displayed an increase in germination percent ($p = 0.0007$). However, *G. sarothrae* also experienced slower germination in both the 1:5 and 1:10 smoke solution treatments. High concentration smoke solution (1:5) significantly inhibited 7 species in either germination%, mean germination time, or both.

0276

Hydrothermal Indices for Classification of Seedbed Microclimate

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The microclimatic requirements for successful establishment of rangeland species are much more restrictive than those required for maintaining mature plant communities. We used a 45-year weather record to parameterize a seedbed-microclimate model for estimation of hourly temperature and moisture at seeding depth for three soil types at the Orchard Field Test Site in southwestern Ada County, Idaho. Hydrothermal-germination response was measured in the laboratory for multiple seedlots of cheatgrass, bluebunch wheatgrass, bottlebrush squirreltail, Sandberg bluegrass, thickspike wheatgrass, Idaho fescue and sagebrush. Germination response models were developed to estimate potential germination rate for every hour of the entire seedbed simulation period. Seedbed microclimate was assessed for each month, year, and season and for each site and seedlot by integrating germination rate estimates into an ecological index of relative favorability for initial germination and growth. This index showed consistent patterns among seedlots for different years, and provides a relatively sensitive index for interpreting favorability of seedbed microclimate among diverse and variable weather conditions. This index could be combined with field data to define minimum weather thresholds for successful establishment of alternative plant materials, in conjunction with weather forecast models for making restoration and fire-rehabilitation management decisions for dormant-fall planting, and evaluation of potential climate-change impacts on plant community trajectories and future restoration/rehabilitation management scenarios.

0277

Uses and Benefits of Consistent Indicators and Scalable, Integrated Sample Design for BLM Local-to-National Data Needs

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Management of U.S. public lands must address multiple objectives at various geographic extents while responding to a continuously increasing number of issues including invasive species, endangered species, climate change, exurban development, wildland fire, wildlife habitat, recreation, livestock grazing and energy development. In order to provide actionable information to support decisions in this increasingly complex environment, robust monitoring and assessment programs must be developed and implemented. However, given resource constraints and the sheer number of monitoring needs, it is no longer possible to implement individual monitoring and assessment plans for each identified use or threat. Across the Bureau of Land Management (BLM), there is a pressing need for consistent, yet flexible, field-based monitoring and assessment activities that incorporate multiple management objectives at various geographic extents or scales. We describe an approach for monitoring and assessment that includes three components: 1) consistent indicators of key ecosystem attributes and methods to measure them; 2) a scalable and integrated approach to sample design; and 3) integration of remote-sensing into monitoring and assessment programs. In this paper we present details and applications of the first two components, and lay out a framework for making remote sensing an operational and integral part of rangeland monitoring and assessment. Using examples from BLM field offices, we illustrate how these components can be used to benefit management of public lands at multiple scales and for multiple objectives.

0278

Weather and Climate Applications for Rangeland Restoration Planning

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Rangeland ecosystems generally have an arid or semi-arid climatology, and are characterized by relatively high variability in seasonal and annual patterns of precipitation. Weather variability during seedling establishment is universally acknowledged as a principal determinant of rangeland seeding success, but restoration planners generally only use weather information retrospectively to qualitatively explain seeding failure. Current state-and-transition models acknowledge that there are a limited set of potential trajectories for moving between undesirable and desirable vegetation states. Current ecological site descriptions include general climate information such as annual precipitation ranges, average monthly temperature minima and maxima, seasonality, and growing-season characteristics but do not address the probabilities associated with transition pathways that are influenced by weather and climate variability. Inclusion of site-specific information on weather and climate variability may improve the utility of these site descriptions and models for rehabilitation and restoration planning. We present sources of weather information for Great Basin rangeland restoration planning, modeling approaches for interpreting interactions between weather variables and the ecological processes driving succession, and general approaches for understanding how weather variability, per se, can be incorporated into alternative planning scenarios for historical, forecast and alternative future climatic regimes.

0279

Rangelands of the Wakhan Corridor: Description, Issues, and Concerns

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During 2006-08 I initiated a rangeland reconnaissance of much of the Wakhan Corridor in northeastern Afghanistan. The Wakhan Corridor is known as a Silk Road route used by earlier travelers including Marco Polo and for explorations by British and Russian agents during "The Great Game" in the late 19th Century. Marco Polo remarked of the value of the Wakhan's high pastures for livestock and wildlife and today the rangelands continue to provide habitat for wild species and for a pastoral economy. Wildlife such as Marco Polo sheep (*Ovis ammon*), ibex (*Capra ibex*), snow leopard (*Uncia uncia*), wolves (*Canis lupus*), and brown bears (*Ursus arctos*) are present and parts of the corridor have been proposed as protected areas to conserve the wild species, the rangelands and the pastoral lifestyles using these areas. The two major pastoral groups using the Wakhan are the Wakhis and the Kirghiz. I identified 12 major vegetation land classes and on sites varying in elevation from 3465 m to 4690 m. The major land classes were named Artemisia Steppe, Artemisia Cold Desert, Alpine steppe, Wetland Meadow, Sedge Meadow, and Low Sage. Mean standing crop (kg/ha) varied from a 1509 kg/ha for the wetland land class to 131 kg/ha for the Low Sage land class. Rangeland degradation was associated with shrub use for fuels, overgrazing, and use of wetlands as a source of peat for fuel. This presentation will discuss the rangelands, the people and the values and concerns regarding conservation of the area and its pastoral systems.

0280

The Role of Beavers as Agents of Ecological Change: Ecosystem Engineering and Herbivory in Lotic and Riparian Ecosystems

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Beavers (*Castor canadensis*, *C. fiber*) are commonly presented as a classic example of a keystone species, i.e., their impact on ecosystems is large relative to their biomass within the system. A beaver's impact results from two distinct pathways: as ecosystem engineers and as agents (herbivores) in trophic dynamics of important riparian plant species. I review the role of beavers as agents of ecological change in riparian and aquatic ecosystems by comparing and contrasting beavers in ecosystems across North America, South America, and Europe. My objectives are to: 1) review the impact of beavers on abiotic and biotic components of aquatic and riparian ecosystems across riverine and riparian systems in a variety of ecosystems, and 2) explore how the interaction strength of beavers (i.e., their impact on a system) varies across systems depending upon a hierarchical set of factors that may dictate their importance in a system (e.g., stream order, plant productivity, plant population dynamics, ecosystem resilience). In pursuing this second objective, it is necessary to frame the discussion within concepts of ecosystem engineering and trophic dynamics. For example, stream order will dictate the influence of beavers in a system primarily by limiting their ability to build dams. Throughout my talk I will discuss the role of beavers within the context of management scenarios to enhance their positive impacts and minimize potential conflict.

0281

Rangelands Use Efficiency and Wool Production in the Arid Environment of Uzbekistan

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This study examined the effect of different levels of protein supplemented fodder on wool production and range use efficiency in the arid environment of Uzbekistan using field and laboratory investigations. Fifty experimental animals were divided into four groups according to age, development stage, and body condition. Animals in the second and third groups received 25% and 35% more supplemented protein, respectively, than animals from the first and fourth groups. On the basis of three years research it was possible to show that animals from both groups with extra supplemented fodder had higher wool quality at both the spring and fall shearing. Wool growth was registered for animals in the second group. Absolute length of spring wool was equal to 12.6 cm, which is 29.8% longer than the wool length of animals in the other groups. The analysis of wool yield of the different experimental groups showed that the animal groups which were raised in the best conditions of the arid rangelands had higher indicators of wool efficiency. Thus, the results testify that a level of protein within 112.5-121.5 g in autumn and 125-135 g in winter are optimal for obtaining the highest wool yield with better quality.

0282

Fire, Herbicide and Disking Effects on Diversifying Crested Wheatgrass Stands in the Northern Great Plains

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Disturbance and seeding techniques were evaluated on grazed and long-term livestock-excluded sites dominated by *Agropyron cristatum* (Agcr) to identify methods diversifying Agcr with native species. Non-grazed sites were burned, disked, burned then disked, or sprayed with glyphosate then disked. Grazed sites received the same treatments plus burning and glyphosate, or burning, glyphosate and disking. Fires were in May 2008 under moderate fire conditions when Agcr was growing at a 3-leaf stage and about 25 cm tall. Glyphosate was applied mid-June at 0.9 L a.i./ha and disking occurred early August. Subplots were broadcast seeded in November with a mixture of three C₃ grasses, three C₄ grasses, all grasses plus three forbs, or remained unseeded. Fire plus disking initially reduced Agcr density on livestock-excluded plots, but doubled density and increase biomass 72% by the second year. Non-treated plots had similar Agcr density and biomass as those receiving fire or disking alone. Glyphosate plus disking caused a lasting reduction in Agcr density, but did not reduce biomass and produced nearly 10 times the annual grass biomass. All treatments reduced Agcr density in grazed plots compared to fire, with glyphosate plus disking and fire plus glyphosate and disking reducing density 77 and 82% and biomass 71%. Annual grasses produced 982 kg/ha in the most effective treatments for reducing Agcr, whereas they were nearly absent in burned plots. Seeded species established poorly, but did best with fire plus glyphosate and disking. Effective treatments were intensive, indicating further refinement is required for less intrusive techniques.

0283

Germination Prediction from Soil Moisture and Temperature Data across the Great Basin

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Preventing cheatgrass (*Bromus tectorum*) dominance associated with frequent wildfires depends, in part, on successful establishment of desirable species sown in fire rehabilitation and fuel control projects. We tested the effects of fire, herbicide applications, and mechanical treatments on predicted germination of five cheatgrass collections, six bunchgrasses, and three forb species using near surface (1-3 cm) soil moisture potential and temperature at 28 sites in the Great Basin. Sites included grasslands (*Elymus* spp. and *Agropyron* spp.) and sagebrush stands (*Artemisia* spp.) either invaded or not invaded by woodland species (*Juniperus* spp. and *Pinus* spp.). Potential germination was estimated using wet thermal accumulation models developed in the laboratory for each seed collection. These models were constructed in previous studies by exposing seeds to a range of constant temperatures and calculating the degree hours above a base temperature threshold required to germinate 50% of germinable seeds. Thermal accumulation and progress toward germination in field seedbeds was calculated from field soil temperatures when soil was wetter than - 1.5 MPa as measured by thermocouples and gypsum blocks. Treatments had much less effect on surface soil moisture and temperature and predicted germination than did site or year. Successful germination for most species was predicted on many sites in spring. Seedling establishment may be more limited by seedling survival than germination. This approach to modeling germination could be used for ranking potential species success and developing more performance-based selection of revegetation species for rangelands.

0284

An Overview of the Research and Studies on Diversifying Crested Wheatgrass Seedings

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Crested wheatgrass (*Agropyron cristatum* sensu amplo[L.] Gaertn.) is an introduced, caespitose grass that has been seeded on millions of acres of Western rangelands. In some important wildlife habitat areas, the reduced plant diversity of crested wheatgrass seedings has stimulated interest in restoring native species. Crested wheatgrass seedings are also seen as an intermediate step in converting cheatgrass (*Bromus tectorum*) dominated rangelands to a functional, desired plant community. The first step in improving plant diversity in crested wheatgrass seedings is to reduce the competition from live crested plants and its seed bank given the strong competitiveness of live plants and this plants ability to produce seed that contributes to a persistent seedbank. These characteristics hinder treatments to reduce its influence and improve conditions for establishing desirable species. Herbicides, burning, mechanical treatments, livestock grazing, droughts, and combinations of these are effective to varying degrees in reducing crested wheatgrass competition. Results from past research and studies will be summarized in this presentation to set the stage for current efforts to improve plant diversity in crested wheatgrass seedings.

0285

Plant Materials Establishment and Performance on Gas Well Pads

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Restoring native forbs and shrubs important for wildlife habitat to disturbances is challenging. Our objective was to evaluate native forb and shrub species establishment on a high elevation sagebrush steppe disturbance. In October 2005, on a well-pad near Pinedale, Wyoming, 23 native forbs and 16 accessions of 12 native shrubs were drill-seeded in single species plots in a randomized complete block design with 4 replications. Establishment was evaluated by counting species densities annually from 2007 through 2010. Differences among accessions and years were analyzed using ANOVA. In general, forb densities were low indicating poor forb establishment and persistence. No differences among species were detected except fewer *Cleome serrulata* plants (less than one plant per square meter) compared with other species in 2008 and 2010. The trend over time was decreasing forb density. There were no differences among shrub accession densities over time. In 2010, 'Wytana' *Atriplex x aptera* had the greatest density (395 plants/ha) followed by 'Snake River Plains' *Atriplex canescens* (197 plants/ha) and *Grayia spinosa* (110 plants/ha). These densities are satisfactory for wildlife food and cover on this site. Densities of other shrub accessions present were similar to each other and ranged from 101 to 21 plants/ha. Broadcast seeding may have improved establishment of forbs and shrubs. Our results suggest shrub cultivars can be used to restore wildlife habitat on disturbed sites. However, the forb results suggest more work is needed to develop establishment technologies and seed sources of forb species important for wildlife habitat.

0286

Classification and Expansion Detection of Western Juniper Using Historical Aerial Imagery

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Historical aerial photographs can provide a chronological record of juniper (*Juniperus* spp.) expansion into sage-steppe ecosystems. Unsupervised (ISODATA) and ENVI's Feature Extraction classification techniques were used to delineate juniper tree cover using a georectified 1951 black and white aerial photograph. This was compared with tree cover delineated from 2005 NAIP imagery, used to measure the extent of expansion in this area. The extracted tree shape files were compared by year for slope, aspect, and solar radiation. Slope, aspect, and solar radiation estimates were calculated using ArcMAP Spatial Analyst (ESRI 2009). Results indicate that total juniper canopy cover increased between 1951 and 2005. North-facing, 5 to 22% slopes and areas that receive low relative exposure to solar radiation have the largest increases in juniper relative cover. Historical imagery provides evidence of temporal vegetation change; however, photo quality may impede classification accuracy. Multiple classification methods may strengthen accuracy of conclusions.

0287

Effects of Patch Burning and Livestock Grazing on Grasshopper Populations in Northern Mixed Prairie in Eastern Montana

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Experiments are lacking in the northern Great Plains that examine the effects of fire and grazing on grasshopper population dynamics, especially during population increases. Interest in fire stems from its use as a management tool and unplanned events; however, there is increased interest in using fire to shift grazing animal distribution and to increase the structural heterogeneity of rangelands. As part of a larger study examining patch burning effects on plant community dynamics, animal performance, grazing distribution and foraging efficiency in northern mixed prairie at the USDA, ARS, Livestock and Range Research Lab in Miles City Montana, we examined how patch burning and livestock grazing affects grasshopper population dynamics from 2007 through 2010. Homogenous and heterogeneous management treatments were assigned to six pastures, with heterogeneity created by burning 25% of each treatment pasture in a given year. Total grasshopper density was estimated by counting the number of grasshoppers within a series of 60, 0.1 m² aluminum wire rings in each plot, with sweep net samples used to establish grasshopper community composition. Patch burning effects on grasshopper populations differed significantly between years, likely due to differences in the timing and intensity of fire. However, grasshopper populations were strongly reduced following fire in some years, including a large reduction following fire in 2009.

0288

Estimating Desert Rangelands Forage Production with High Spatial Resolution Satellite Imagery and Vegetation Indices

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Determination of rangeland forage production is usually expensive and time consuming. Remote sensing data have been used to estimate net primary productivity over large-scale landscapes. The objective of this study was to determine if vegetation indices derived from high spatial resolution satellite imagery could accurately estimate aboveground biomass in the arid rangelands of the Chihuahuan Desert Rangeland Research Center (CDRRC) in south-central New Mexico, USA. QuickBird ortho-ready satellite imagery with spatial resolution of 2.4 m in multispectral bands and panchromatic resolution of 0.6 m for the study area was obtained on November 20, 2008 at the end of the monsoon and associated active growing season. We measured forage production (kg/ha) during November, 2008 on 10 permanent transects in each of four extensive pastures at CDRRC. Shrubs were masked out of the satellite image. We identified 24 x 60 meter plot for each transect (n = 40) from the image. Transformed Normalized Vegetation Index (TNDVI) and Soil Adjusted Vegetation Index (SAVI) were calculated for each plot associated with each transect. Regression was used to estimate the relationship between actual aboveground biomass and TNDVI and SAVI. Aboveground biomass was linearly related to TNDVI and SAVI indices ($R^2 = 0.74$ and 0.82 , respectively). These results indicate that vegetation indices derived from high spatial resolution satellite imagery can be a useful tool for estimating annual forage production on arid desert rangelands.

0289

Fostering Healthy Lands for Small Acreage Success in South Dakota

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The number of small acreages in South Dakota (1-49 acres) increased 27% from 2002-2007. While this growing sector may be well-intentioned, in many cases resource management and conservation are deficient due to a lack of experience. The land use by small acreage owners is often intense, leading to erosion, degradation of water and air quality, and the spread of invasive species both on small acreages, as well as, throughout the communities in which they reside. Traditionally, programming efforts by South Dakota Cooperative Extension Service (SDCES) have focused on range improvement education targeting farms and ranches in South Dakota. In response to this increase in small acreages, SDCES created an issue-based team in 2009 to address natural resource management of small acreages in the state. Initial program topics at workshops and on-site demonstrations included animal care and stewardship of land resources, with a focus on carrying capacity and weed control within the Black Hills region. The use of animal care education, particularly horses, was to draw the intended audience into programming on improving range condition among small acreage owners. Small acreage owner participation grew 43% between 2009 and 2010. Subsequent programming topics have been driven by audience surveys. Changes in programming topics have taken a comprehensive approach to encompass both the aesthetic and production values small acreages in the Black Hills possess.

0290

Bird Activities that Expand Existing Plant Community Ranges

Anne Bartuszevige

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Perhaps the best studied form of biotic seed dispersal is that done by birds. Birds have informed hypotheses regarding explanations of why plants form such energetically expensive propagules. Birds have been hypothesized to contribute to the long-distance dispersal of plant seeds after the retreat of the glaciers in the last ice-age, thus expanding the range of plants faster than would have otherwise occurred. Ducks have been hypothesized to disperse seeds among wetlands thereby creating communities of plants that provide suitable food resources. Finally, models of seed dispersal shadows can help to identify habitats where seeds are likely to be defecated. However, the ability to track direct changes in plant communities due to seed dispersal by birds has lagged mostly due to the difficulty in obtaining data. To document such changes, observation of multiple events is required – the bird eats the fruit with the seed, the bird travels x distance away, the seed is defecated in a new area, the seed is viable, and the seed grows to form a new reproductive plant. The sheer number of seed dispersal events that would need to be observed precludes this kind of documentation/evidence/results. Often, the results of such a study are inconclusive. Therefore we are often relegated to making correlations between observations of seed dispersal and vegetation community. In this talk we will explore the evidence for birds as plant community architects despite the difficulty in obtaining direct observations.

0291

Developing and Implementing a Strategy for the Conservation of Shrub Steppe/Rangelands in South Central Washington

Julie Conley

South Central Washington Shrub Steppe/Rangeland Partnership, Yakima, WA, United States

The South Central Washington Shrub Steppe/Rangeland Partnership is a group of government agencies, non-profits and other cooperators that have come together for the mutual purpose of conserving and restoring the shrub steppe/rangeland landscape in Benton, Yakima, Grant, and Kittitas Counties in Washington State. Formed under an MOU in 2006, the group has 15 formal member entities including all major federal rangeland owners in the region, Yakama Nation, State Department of Fish and Wildlife, NRCS, Conservation Districts, and environmental NGO's. In Sept. 2009, the group funded a coordinator and set to work developing a regional strategy for the conservation of shrub steppe/rangelands. This strategy was completed in August of 2010 and the group is now probing deeply into the feasibility of needed actions and opportunities; identifying key players and the tasks they are committed to assisting in or completing. This presentation will describe the rangeland setting of South Central Washington, the conservation targets that are the focus of the Partnership's work, the critical threats identified and ranked by the group, and the broad strategies to be pursued by the Partnership to ensure longterm conservation of shrub steppe/rangelands. It will further discuss current and future projects planned for implementation of the strategy and lessons learned as a partnership. The group's priority strategic action is to reduce the amount of fire in key habitat areas and buffers through improved prevention and suppression efforts in predominantly dry, low elevation Wyoming big sagebrush communities. Challenges and progress in this area will also be discussed.

0292

Variation among SamplePoint Users with Respect to Shadows and Other Variables

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SamplePoint is an image-analysis program that is used to classify true color, very large-scale aerial (VLSA) imagery. SamplePoint works by overlaying a grid of a user-defined number of cross-hairs over an image. In this trial, we used 100 cross-hairs on an image with a 4 x 3-m field-of-view. Each cross-hair has a center pixel that is the sample point from which observations are recorded. We employed 4 people (users) ranging in age from 18 to 40 years, and having different amounts of field training, and image analysis experience. The users analyzed 150 images from the Grand River National Grasslands for 20 independent variables. Variables included bare ground, litter, rock, shadow, life form, and several individual species including crested wheatgrass, western wheatgrass, blue grama, and needle and thread. SamplePoint automatically writes a user's observation / classification to an Excel file in real time.

User measured cover variables, such as shadow, were similar (same general trend, Kendall W statistic). However, there were significant differences ($P < 0.05$) among the four judges (ANOVA). This is consistent with other findings of among-user variability for SamplePoint. We believe these differences relate to individual users' visual perceptions (ophthalmological differences) and mental interpretations of image variables. The implication is that if data sets will be compared over time, an individual user must analyze the complete data set so that change-over-time detection is not confounded by among-user variability.

0293

Understanding Priority Effects May Help Improve Restoration Outcomes and Establishment of *Artemisia tridentata* spp. *wyomingensis*

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Priority effects, where an earlier growing species affects the establishment, growth, and reproduction of a later growing species, may have lasting effects on the dominance of the system and should be considered when developing a restoration plan. Here, we explore the effect of soil pre-conditioning (i.e. soil legacies-a mechanism for priority effects) by nine to ten mixed-grass prairie species on growth of *Artemisia tridentata* spp. *wyomingensis* using a plant-soil biota feedback experiment designed to detect soil biota effects (i.e. microbial effects) while controlling for nutrient effects. Soil inocula for this study originated from two mixed-grass prairie sites in eastern Montana. Beneficial effects of soil preconditioning (i.e. feedback) on *A. tridentata* spp. *wyomingensis* growth were detected when soil was pre-conditioned by *Artemisia frigida*, *Koeleria macrantha*, and *Sphaeralcea coccinea*. Negative effects were observed for soil conditioned by *Hesperostipa comata*, *Poa secunda*, *Sphaeralcea coccinea*, and *Vulpia microstachys*. Effects varied with soil origin (i.e. site effects) suggesting some conditionality of results. Although not conclusive, this work has identified some species that may inhibit *A. tridentata* spp. *wyomingensis* via changes in soil biota and other species that may promote its establishment via changes in soil biota. Incorporating knowledge of soil feedback effects (i.e. soil legacies) and priority effects may ultimately help inform decisions related to assembling species mixes and/or successive planting strategies. Restoring systems that naturally develop over successional time is challenging and outcomes are often uncertain, added knowledge of priority effects will increase the odds of establishing relevant species.

0294

The Role of Relative Size and Nitrogen (N) Availability in Competitive Interactions between Cheatgrass (*Bromus tectorum*) and Bluebunch Wheatgrass (*Pseudoroegneria spicata*)

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Reestablishing native perennial grass species such as bluebunch wheatgrass (*Pseudoroegneria spicata*) is one management tool for restoring lands dominated by cheatgrass (*Bromus tectorum*), an exotic annual grass. Yet, reseeding perennial grasses is often unsuccessful due to cheatgrass' early emergence time and ability to preempt and quickly utilize resources. We conducted a greenhouse study investigating the role of relative size and nitrogen (N) availability in competitive interactions between cheatgrass and bluebunch wheatgrass, with the intent of improving rangeland revegetation practices. We hypothesized that cheatgrass growth is more responsive to increased N than bluebunch wheatgrass and that competitive ability of bluebunch wheatgrass seedlings increases with seedling size relative to cheatgrass. In an addition series experiment, we combined four densities of each species, three size cohorts of bluebunch wheatgrass (seeds, two-leaf, and four-leaf seedlings), and two N treatments (ambient and high) for a total of 96 experimental units replicated four times. For both species, we predicted individual average biomass as a function of densities of each species, bluebunch wheatgrass size cohort, and N treatment. Cheatgrass responded to added N by accumulating more biomass than bluebunch wheatgrass. As predicted, when the species were planted simultaneously cheatgrass suppressed bluebunch wheatgrass growth, but cheatgrass had little effect on larger bluebunch wheatgrass seedling biomass across both N treatments. Furthermore, the larger bluebunch wheatgrass seedlings suppressed cheatgrass growth. These results suggest that techniques that allow perennial grasses to achieve a size advantage over cheatgrass may increase the chance of reseeding success, even when resource availability is elevated.

0295

Use of Direct and Indirect Estimates of Crown Dimensions to Predict One Seed Juniper Woody Biomass Yield for Alternative Energy Uses

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Throughout the western United States there is increased interest in utilizing woodland biomass as alternative bioenergy source. A pilot study was conducted to predict juniper (*Juniperus monosperma*) chip yield from tree-crown dimensions measured on the ground or derived from Very Large Scale Aerial (VLSA) digital imagery. The study was conducted in January 2009 at the Corona Range and Livestock Research Center in central New Mexico. We harvested 57 individual trees from a 0.10 ha plot and 17 tree clumps (72 individual trees) from a neighboring site which had been surveyed with VLSA digital imagery. We recorded crown and stem measurements on all trees shortly before the harvest date. A timber extractor and a Vermeer grinder with a 10 cm screen were used to harvest and grind trees. Juniper chips from trees were collected and weighed to determine green weight. Random grab samples were extracted from each tree to determine dry matter content of chips which was 67.1 % (± 0.04 ; n=156). Overall, tree crown dimensions accounted for >70% of the variation in chip yield and were better predictors of chip yield of tree clumps in aerial images than of individual trees measured on the ground. Longest tree clump crown diameter was the best predictor of tree clump chip yield ($y=81.4x-1,137.8$; $R^2=0.94$). We conclude that VLSA image-derived measurements are strong predictors of juniper chip yield for alternative bioenergy use.

0296

Diversifying Crested Wheatgrass Seedings in Northern Nevada

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Because it can be reliably established to compete against cheatgrass invasion, crested wheatgrass is often seeded in lower elevations burns of northern Nevada. Once these sites have been secured against weedy monocultures, the opportunity for diversifying with native species may exist. The study area, formerly dominated by Wyoming big sagebrush, was seeded to crested wheatgrass during the 1970s. Objectives of this research were to determine the effect of various control methods on crested wheatgrass and the effect of reducing crested wheatgrass on establishing seeded species. Treatments for crested wheatgrass reduction included herbicide (glyphosate) applications of spring and spring + fall spray, 3-way disking, and combined spring spray + 3-way disking. A mixture of site-adapted native species was seeded during October 2008 with a Truax rangeland drill. First year analysis showed the following (at $p < 0.05$): 1) herbicide treatments were more effective than disking in reducing crested wheatgrass cover and density, 2) there were no significant differences in effectiveness among the 3 herbicide treatments in reducing crested wheatgrass cover and density, and 3) disking increased crested wheatgrass density. Seeded species that have established to date include basin wildrye, bluebunch wheatgrass, bottlebrush squirreltail, Indian ricegrass, needle-and-thread grass, western yarrow, Lewis flax, Munro globemallow, and Wyoming big sagebrush. Seeded native grasses germinated on plots with and without crested wheatgrass control, but were much taller and more robust in plots where crested wheatgrass was suppressed. Additional plots were established during 2010 to test for differences between years, and to compare additional herbicide treatments.

0297

Herbivore Impacts on Life-Stage Transitions of an Endangered Orchid, *Spiranthes parksii* Correll

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Herbivory disrupts the life cycle of *Spiranthes parksii* Correll, an endangered orchid of east-central Texas. Disruption of the life cycle at different stages has the potential to negatively impact the fitness of an individual, and the effect of individual loss of fitness on *S. parksii* population dynamics is not well understood. We experimentally manipulated herbivory by excluding large mammalian browsers (rabbit-sized or larger) from half of our experimental units. We treated half of the protected and half of the unprotected plots with prescribed fire to explore the interaction between fire and herbivory. We collected demographic data to quantify stage transitions for each treatment group. Mammalian browsers had a large impact on the transition from flowering stalk to flower production. All herbivory had a significant impact during rosette production, potentially reducing fitness by removing biomass. However, there were significant increases in leaf area in protected plots. Our data demonstrate major disruption of *S. parksii* life-stage transitions by large mammalian browsers. Continued data collection is necessary to determine the consequences of this disruption for *S. parksii* populations.

0298

Vegetation Structure and Composition at Greater Prairie-Chicken Nest and Brood Sites: Drivers for Success?

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Greater Prairie-chickens (*Tympanuchus cupido pinnata*) are a grassland species of conservation concern. Although prairie-chickens have experienced decline over much of their range, the Nebraska Sandhills has one of the few stable remnant populations in North America. In 2009 and 2010, we studied prairie-chickens on private rangelands in Rock and Brown Counties. We fitted 25 hens in 2009 and 65 hens in 2010 with radio collars to locate nest and brood sites and to determine nest and brood success rates. Hens were trapped on leks during the breeding season and monitored throughout the summer using pickup-mounted and handheld telemetry systems. Nests were considered successful if ≥ 1 egg hatched and broods successful if ≥ 1 chick survived. At nest sites and brood rearing-sites, we collected vegetation structure and composition data. Plant composition was estimated by functional groups using a quadrat method and vegetation structure was measured using the Robel pole and coverboard. Apparent nest success was 60% in 2009 and 31% in 2010. Brood success at 21 days post-hatch was 57% in 2009 and 50% in 2010. For nest locations in 2009, hens tended to select patches with relatively dense cover (15.34 cm VOR) compared to random points (6.26 cm VOR). Overall, vegetation structure and composition appeared to have mixed effects on reproductive success.

0299

Using VHR Imagery for Rangeland Monitoring and Assessment: Some Statistical Considerations

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The availability of very-high-resolution (VHR) imagery and the development and validation of techniques for processing those data into indicators of ecosystem status and function has opened the door for VHR imagery to be used in rangeland monitoring and assessment. However, VHR imagery can be expensive in a larger study and, like any survey measurement, studies that rely on VHR-image-based indicators will be subject to various forms of survey error that can lead to biased results or inflated standard errors. We will discuss the use of VHR imagery from the perspective of minimizing survey error in estimates. In this paper, we discuss survey errors in the context of VHR-image-based methods in rangeland monitoring and assessment. Our discussion will include the importance of probability sampling to generate scientifically credible estimates, including two-phase sample designs to minimize costs; measurement errors in VHR-derived indicators; and model-assisted estimation to integrate data from multiple sources, improve precision and adjust for sources of errors. We demonstrate the effects of these statistical considerations using example datasets where VHR imagery and concurrent, comparable field data were collected. Finally, we propose practical ways to conduct statistically-sound rangeland monitoring and assessment using VHR imagery.

0300

Regional Economic Implications of Post-CRP Land Use

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The uncertain future of the Conservation Reserve Program has created substantial interest for agricultural producers, rural businesses, community leaders, sportsmen, and wildlife organizations. Many regions of the upper Great Plains have participated heavily in the CRP as evidenced by program acreage reaching land enrollment limits; however, current enrollment and re-enrollment criterion are expected to substantially reduce CRP acreage in many parts of the Great Plains. The divergence of interests between pursuing post-CRP lands for agricultural production versus retaining the wildlife habitat and wildlife populations supported on CRP lands presents land owners and agricultural producers with important land management decisions over the next several years. This research attempts to examine the regional economic implications of post-CRP land use among traditional agricultural uses, wildlife production, and multiple-use practices. Of particular interest is whether multiple-use management on post-CRP lands can produce similar returns to landowners and producers as traditional land uses, and determine the effects of multiple-use management on post-CRP lands on regional economic output. Direct economic impacts are estimated for each land use designation as land changes from active CRP to post-CRP management. A scenario driven approach was used to reflect potential regional adoption of various land management options for post-CRP land. The results from each scenario are used with the North Dakota Input-Output Model to examine the indirect and induced economic effects on the regional economy stemming from various land management alternatives for post-CRP land use.

0301

Impacts of Native and Exotic Grasses on Forb Seedling Growth and Establishment

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To improve degraded habitats for species like the sage-grouse and to increase species diversity of restored plant communities, land managers are using a growing number of forbs in revegetation mixtures. More information is needed on forb seedling response to competition with native and exotic grasses, especially for revegetation of areas infested with *Bromus tectorum*, an annual grass throughout the Great Basin and observed increasing in Montana. We conducted two experiments: the first in a greenhouse to assess the impact of two native grasses and *B. tectorum* on the biomass and relative growth rates of five native forbs; and the second a field experiment to assess the effect of *B. tectorum* densities on the biomass and survival of four native forbs. Forbs differed in their response to grasses, both native and exotic. Native grasses reduced the growth rates of two forbs, but *B. tectorum* reduced biomass and growth rates of all forbs by 50-96%. In the field experiment, three of four forbs had reductions in biomass of more than 90% at densities greater than 80 *B. tectorum* plants m⁻², while one was reduced by slightly less at densities greater than 200 plants m⁻². Traits such as contrasting root morphologies, emergence dates and smaller biomass may be used to select species that are better able to establish and grow in the presence of *B. tectorum*.

0302

Effects of Weed Induced Alteration of Plant Composition on Patterns of Vegetation Recovery Following Herbicide Control of Leafy Spurge

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Leafy spurge (*Euphorbia esula*) is an aggressive invasive plant that is widely distributed throughout the Northern Great Plains where it is well recognized for having wide ecological tolerances and broad competitive effects on local species distribution and abundance. Herbicides have been effective in reducing cover and frequency of leafy spurge in a variety of situations. However, information regarding the relatively long-term patterns in vegetation recovery following successful suppression is limited. We used long-term permanent plots to monitor overall efficacy of herbicide control and general patterns of vegetation response, and to evaluate the potential effects that altered floristic composition may have on patterns of recovery. Permanent plots were established in Theodore Roosevelt National Park, ND. Plots were evaluated immediately prior to herbicide application in 1992 and monitored every 1 to 3 years until 2009. Within 2 years following herbicide treatment (1994), foliar cover of leafy spurge was reduced 85 to 95%; however, no response in total vegetation cover was observed until 2000 when total cover increased 40 to 100% compared to pre-treatment values. Non-hierarchical cluster analysis using pre-treatment foliar cover values indicated that plots could be grouped into 4 clusters based on the abundance of 2 dominant species (*Hesperostipa comata* and *Carex filifolia*). Post-treatment analyses of the 4 clusters over the 17-year study period indicated that initial floristic composition did influence patterns of recovery, but not in ways that we predicted. The results suggest that altered competitive hierarchies interact with other abiotic and biotic factors to influence patterns of vegetation recovery.

0303

Alfalfa Hay Supplementation Increases Ponderosa Pine Browsing by Goats in Winter

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Conifer encroachment into foothill rangeland reduces forage production for livestock and wildlife, reduces grassland bird habitat, and decreases the flow of water from springs and creeks. Our previous research determined that targeted goat browsing is a potential tool for suppressing ponderosa pine encroachment. Goats supplemented with small amounts of protein and energy will eat large amounts of ponderosa pine (> 30% of their winter diets), and goats fed a low-cost supplement (alfalfa pellets) consume similar amounts of ponderosa pine as goats fed a high-cost supplement (Sheeplix). We hypothesized that alfalfa hay may be an even more effective, and less expensive, supplement because the roughage might buffer the toxins in ponderosa pine and enable goats to browse the trees more heavily. A 4-year grazing trial was conducted in west-central Montana. For one week in late winter 2007-2010, six 0.5 ha pastures were grazed at a high stock density with 18 female goats per pasture. Goats in 3 of the pastures were supplemented daily with alfalfa hay, and goats in the remaining 3 pastures were supplemented daily with barley-based pellets. Results indicate that goats supplemented with alfalfa hay inflicted more browsing damage to ponderosa pine trees than goats receiving the pellets ($P < 0.05$). Goats fed hay averaged 36% browse utilization of the trees, whereas goats fed the pellets averaged 27% browse utilization of the trees. There was no difference in the percentage of terminal leaders removed by goats supplemented with hay versus the pellets, averaging 8% terminal leaders removed.

0304

An Invasive Grass Alters Tallgrass Prairie Fuelbed Characteristics and Reduces Burn Probability

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Rangeland fire ecologists have long sought to understand the effects of fire on invasive species, but fire ecologists more recently have turned their attention to alteration of rangeland fire regimes by invasive species. Invasive woody plants have drawn comparatively more attention than invasive herbaceous plants, including grasses. Determining that an invasive species fire regime has been established includes three steps: 1) demonstrating altered fuelbed characteristics, 2) demonstrating that the spatial and/or temporal distribution of fire has been changed due to fuelbed alteration by the invasive species, and 3) demonstrating a shift in community composition to the dominance of the invasive species that "fueled" the new fire regime. We present evidence focused on the first two steps, suggesting that a cool-season grass, tall fescue (*Lolium arundinaceum*) might alter the fire regime of native tallgrass prairie in which it invades. We report field data on the spatial pattern of tall fescue invasion with respect to altered fuelbed characteristics. We also present the results of a spatially-explicit model of burn probability under different invasion scenarios, with respect to altered distribution of fire in invaded landscapes. We discuss these results in the context of prescribed fire management and invasive species control.

0305

USDA-Natural Resources Conservation Service and Prescribed Burning on Non- Federal Lands

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USDA-Natural Resources Conservation Service is a technical assistance agency that provides assistance to non-federal landowners through local Soil and Water Conservation Districts. This assistance is aimed at meeting the land manager's objectives and the needs of the soil, water, animals, plants, air and human resources available on the unit. These objectives are achieved through a conservation planning process with the land manager. The planning process revolves around an inventory of the available resources on the land unit. On rangelands the basic unit of inventory is the ecological site. The ecological site descriptions provide a valuable tool for supporting decisions, measuring progress toward objectives, and assessing risk. The state-and-transition models in the ecological site descriptions discuss the role of fire as a vital part of the disturbance regime needed to maintain the resilience of many rangeland ecological sites. As this information on the role of fire gets incorporated into the ecological site state-and-transition models, the acceptance of prescribed burning as part of a disturbance regime necessary to maintain a sustainable range/livestock enterprise is increasing. Understanding the relationship of fire to other ecological processes is essential to develop a conservation plan that results in incorporating needed conservation practices and management actions to achieve short term objectives and long-term goals. Prescribed burning is a conservation practice and management action that can be incorporated into conservation plans to meet those stated objectives and goals.

0306

Environmental Influences on Structural Characteristics of Cheatgrass (*Bromus tectorum*)

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Cheatgrass (*Bromus tectorum*) is commonly described as an invasive, winter annual grass. Such grasses are characterized as expending most of its energies on seed production and little energy on root production. Perennial grasses are characterized as either a bunch or rhizomatous with energies directed to root production. We have observed that cheatgrass is markedly varied in its phenologic appearance and life-growth style and such variance is manifested in response to differences in ecological environment and encountered stresses. Phenologic measurements of tiller number, tiller length and root mass ratios of glass house grown cheatgrass are compared to those of cheatgrass growing in arid undisturbed, arid-heavily grazed and mowed-irrigated environments. Initial studies of cheatgrass grown in the glasshouse environment reveal 52 of 60 weighed seeds germinated at one week and 58 seeds ultimately germinated. In a subset of 10 plants harvested at 8 weeks, average numbers of tillers per plant were 20.8 (14-29) and average tiller length was 15.5 cm (12.5-19.2). New tiller formation was noted throughout the observation period. However, no tillers produced seed. End of season, twice mowed, irrigated cheatgrass averaged 15 (3-31) tillers, average tiller length was 12.6 cm (9.8-16.1) with seeded/unseeded tiller ratio of .56 (.33-1). Preliminary measurements of field grown material document significant structural variance with emphasis on root production and that production facilitates ongoing tiller growth until seed is produced. We believe these results explain why overgrazing, i.e. tiller control, will not limit cheatgrass invasion because sufficient root mass is maintained to produce shorter tillers capable of producing seed. Efforts for cheatgrass control should emphasize root mass reduction with germination prevention.

0307

Reintroducing Fire into Rangeland Ecosystems: Ecological Adaptations vs. Social Constraints

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Rangeland ecosystems evolved with relatively frequent fire and thus the biotic ecosystem components are well-adapted and often depend on fire as a driver of ecosystem function. Following European settlement, fire was suppressed and all but removed from much of the North American landscape often altering key ecosystem properties. A number of scientists and land managers are experimenting with fire to discover key variables that are necessary to support the use of fire on rangeland ecosystems. However, one barrier to successful implementation of a fire regime is the view of fire as a management tool often applied once rather than as a regime over time. A summary of fire research reveals that much of our knowledge of fire is limited to short duration and small or non-replicated experiments. Limited large scale and long-duration studies, suggest that ecosystems are well adapted to frequent fire, and the re-implementation of fire is largely limited by social constraints.

0308

Ecological Sites: Organizational Tool for Outcome-Based Land Management

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Managing for sustained ecosystem services from rangelands involves complex interactions among soils, plant communities, topography and the prevailing environmental conditions across different land forms from local patches to entire landscapes. This complexity has contributed to prior difficulties in organizing information (both experimental and experiential) on ecological processes at scales appropriate for implementation of management practices, monitoring, and reporting on the societal benefit regarding conservation effects. The contemporary adoption of ecological sites descriptions by land management agencies, and the associated information contained within these descriptions [physiographic and climatic features, soils, plant communities (state-and-transition models, composition, production, growth curves), animal communities, wildlife interpretations, hydrologic functions, and recreational uses] provides the foundation for an effective organizational tool that can be implemented for outcome-based land management. Use of the ecological site as an organizational tool permits efficient accountability of implemented land management practices for the desired outcome(s), permits the assessment via proper monitoring of the effectiveness of the management practice for the desired outcome(s), and provides the infrastructure for reporting on conservation efforts at the individual site level as well as the ability to scale to regional and national efforts.

0309

Can Targeted Sheep Grazing or Mowing Suppress Sulfur Cinquefoil (*Potentilla recta*) on Rangeland?

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Sulfur cinquefoil (*Potentilla recta*) is a long-lived perennial weed that is a prolific seed producer and adapted to nearly every soil type and vegetation complex in the western U.S. Previous research has demonstrated that defoliation may be an effective tool for suppressing sulfur cinquefoil. The purpose of this 3-year study was to assess the effectiveness of defoliation by mowing and sheep grazing on suppression of sulfur cinquefoil on foothill rangeland in northwestern Montana. Treatments were mowing to a 15-cm stubble height and sheep grazing with and without protein supplementation. Treatments were applied within 0.5-ha pastures at two timings: late June (sulfur cinquefoil in flowering stage) and mid-July (sulfur cinquefoil in early seedset stage). Percent cover of sulfur cinquefoil was used as a covariable in the data analysis. Initial results indicate that sheep readily consume sulfur cinquefoil and can suppress reproduction of the plant. Relative utilization of sulfur cinquefoil averaged 59% for grazing treatments compared to 37% for mowing ($P < 0.05$). Both grazing and mowing reduced the number of buds and flowers of sulfur cinquefoil by 98% compared with controls. Neither protein supplementation nor timing of grazing influenced the botanical composition of sheep diets. Sheep diets averaged 45% sulfur cinquefoil and 28% perennial grasses. Sheep selected diets higher in crude protein (CP) in June than July and unsupplemented sheep selected forage higher in CP than supplemented sheep. Yearling ewes were not able to meet CP requirements from forage alone and need protein supplementation to maintain production on sulfur cinquefoil-infested rangelands.

0310

Object-Oriented Segmentation and Classification of High Resolution Imagery Evaluating Fire-Carrying Fuel Variables of Pinyon-Juniper Woodlands in the Great Basin

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We utilized remote sensing and GIS technologies to assess the relationship between fire-carrying fuel variables sensed remotely, and field-based measurements collected as part of the Sagebrush Steppe Treatment Evaluation Project (SageSTEP). Fuel variables were evaluated for fuel-reduction treatments, including prescribed fire, tree cutting, and shredding of pinyon-juniper trees. Imagery was collected in June of 2009 using a turbocharge Cessna 206 aircraft equipped with a Vexcel UltracamX digital camera producing 6.1 cm digital color imagery. eCognition Developer 8 software was used for object-oriented image segmentation and classification that included spectral, spatial, and contextual parameters. We investigated three hierarchical classifications of fuel variables that include cover, density, and biomass measurements. Classification level 1 included vegetation, bare ground/rock, and down woody debris; level 2- trees, shrubs, herbaceous vegetation, and litter; and level 3- dominate vegetation by species for trees and shrubs, perennial bunchgrass, annual grass, and fuel load size class. The multiresolution (scale, shape, and compactness) segmentation parameter that distinguished the greatest spectral differences (scale) between fuel variables using hue, saturation, and intensity was 400 which produced the smallest sized objects evaluated. A lower shape value (0.5-0.8) resulted in objects more optimized for spectral heterogeneity across all fuel variables while compactness remained constant (0.5). Further segmentation and classification parameters are being evaluated to more accurately estimate remotely-sensed fuel variables.

0311

How Water Development can Increase the Carrying Capacity of the Land and Improve Riparian Areas

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Dee Hillberry, a cattle rancher out of Thermopolis, Wyoming, has developed a ranch in foothill terrain that covers from 7 inches to 20 inches precipitation. The ranch has about 800 breeding cows. Hillberry has fenced and developed water for livestock to have 28 pastures including private, State and Bureau of Land Management lands. He has installed 20 miles of pipeline and 31 stock tanks to disperse the cattle throughout his rangeland. In his rotational plan, those pastures that are used for spring use during the critical growing period are typically not used until fourteen months later. He generally does not graze the pastures the previous year that they use for spring turn out. Dee has seen an increase in desirable vegetation in the riparian areas. Willows, cottonwoods, sedges and rushes have increased. Riparian areas and streambanks have improved in condition. In a significant change from typical livestock production systems, Hillberry uses irrigated meadows to winter cattle so that they are grazing pasture year round. This saves the formerly big expense of machinery, fuel and labor that was required when the meadows were hayed.

0312

Comparison of the Effects of Fire on Sagebrush Steppe 3-Dimensional Structure and Biomass using Fusion of Terrestrial Scanning Laser and Airborne Digital Photography

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Weed invasions, fire, and anthropogenic land use have led to habitat loss and fragmentation, contributing to candidate listing of sage-grouse as threatened species. Past studies have demonstrated the association of increasing avian species richness with increasing complexity of 3-dimensional (3-D) vegetation structure. We hypothesize that recently burned or degraded shrubland should exhibit less 3-D complexity than intact landscapes. However, 3-D structure in shrubland and grasslands is understudied because they fall within the ranging error (± 0.15 -m to 1.5-m) of most airborne RADAR and LIDAR systems. Consequently, this study has the objectives of using a terrestrial scanning laser (TSL) with ± 2 -mm range accuracy to: 1) characterize and compare the 3-D vegetation and soil structure of four ~40-m diameter plots [two crested wheatgrass (*Agropyron cristatum*)- and two big sagebrush (*Artemisia tridentata*) sites] in the Curlew National Grasslands, Idaho and 2) use data fusion techniques to link the 2-cm-spaced TSL data to very-high resolution (1-mm and 8-mm) digital aerial photography (30-m AGL) for enhanced visualization of sage-grouse habitat. We virtually and automatically derived height and foliar diversity, leaf area index, vegetation cover and bare ground, biomass, and surface roughness in each plot and compared this data to coincident field data. We found similarity in 3-D structure between the big sagebrush sites. These findings demonstrate that TSL has important utility for detecting structural characteristics of vegetation and soil at grains of 2 to 15-cm that are important to biodiversity and habitat and fire fuel quality.

0313

Post-Fire Soil Water Repellency, a Preliminary Report: Extent and Characteristics within the Pinyon-Juniper Woodlands of the Eastern Great Basin

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In pinyon-juniper (PJ) systems the reestablishment of desirable species following fire may be hampered by the presence of a water repellent soil layer that alters natural hydrologic and nutrient cycles. While this effect has been shown in several instances, the extent of this condition is not well understood. To better understand the spatial extent of water repellency (WR) we selected several fires across the state of Utah for WR sampling. Within the boundaries of each fire, soil pH, clay and organic matter content, Heat Load Index, and annual precipitation GIS data were acquired and used to randomly select sites. These variables were selected due to their documented influence on soil water repellency in other ecosystems and availability in GIS format. At each site the presence, severity and thickness of WR was determined. These data were then related to PJ biomass, trunk diameter, and burn severity data collected at the site, and PJ canopy cover and various topographic and precipitation data that were extracted remotely. Soil WR was found at 40% of all points sampled and its presence was directly correlated to PJ canopy cover measurements (slope = 0.84, y-intercept = 0.05, and $R^2_{adj} = 0.68$). Where found, soil WR averaged 1.55 cm thick, Water repellency severity is still being analyzed. Main effects models indicate that soil organic matter, tree biomass, and burn severity are also significantly correlated with WR and the inclusion of these variables with tree cover results in a stronger model with a 0.79 R^2_{adj} .

0314

How Developing and Following Through with a Resource Management Plan Has Improved the Range and Relationships with Ranchers in the Cody Wyoming Bureau of Land Management Office

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Jack Mononi and the rest of the staff in the Cody Wyoming Bureau of Land Management (BLM) field office has taken a difficult situation and turned it into a positive situation. The Cody Field Office Resource Management Plan (RMP) provides for grazing on public lands. The livestock grazing management objective is to improve forage production and ecological condition for the benefit of livestock use, wildlife, and watershed resources. Livestock grazing will also be managed to provide for the protection or enhancement of other resources. Livestock grazing will continue on public lands, but not at the sacrifice of other resources. The 1990 RMP identified 55 high priority allotments that had major conflicts with other resources and the current livestock grazing management. The Cody Field Office made it a priority to improve this situation and have changed the grazing management at least one time on the high priority 55 allotments and on approximately 90% of the 235 allotments in the field office. Shortening the grazing period and changing the time of use were some of the changes made. Results have been good with most rangelands showing an upward vegetative trend and/or are meeting or making progress towards meeting site-specific resource objectives. The Cody Field Office was able to implement their RMP without a lot of conflict with their permittees. They did not have one single lawsuit through the process. Because of their efforts they were awarded the Rangeland Stewardship Through Collaboration award from the Department of Interior in 2008.

0315

Multiple Uses and Associated Values on Canadian Publicly Managed Rangeland: A Case Study of the Federal Community Pasture Program

Brant Kirychuk

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The multiple uses and benefits of the world's rangelands are now more recognized, as well as receiving increased pressure from a variety of users. Private rangeland managers are just now realizing the challenges and opportunities in dealing with the multiple users of rangelands. Most publicly managed rangeland has a mandate to consider all users of the rangelands. For the most part the benefits to society and value of these benefits have not been recognized or quantified. Grazing is the most commonly associated use with rangelands, but there are also a number of values to society provided by these lands related to water quality, biodiversity and soil conservation, plus others. This has put increased pressure on these lands, and also increased the interest in understanding the value to society as a whole. This paper explores the multiple uses and values of one sector of public land in Canada, the Agriculture and Agri-Food Canada Community Pastures. These are public lands managed both for conservation and livestock production purposes. The costs covered by all users, and benefits afforded public and private interests were valued for these lands. It was determined that the 930,000 hectare community pasture program had an annual value of \$54.9 million to all users. There are direct beneficiaries that pay costs associated with the financial benefit they receive, but there are public benefits which are managed for and thus can rationally be supported with public sector funds.

0316

Range Cattle Winter Water Consumption in Eastern Montana

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Water consumption and dry matter intake interact to alter range cow productivity. Winter, air and water temperature may influence water consumption. Objectives of this study were to determine influences of water and air temperature on quantity and pattern of water intake. Six paddocks (average area 320 ha) were grazed from December 2009 through February 2010 by 79 pregnant range cows at the USDA-ARS Fort Keogh Livestock and Range Research Laboratory. Three paddocks provided "cold" (2.4°C) and three "warm" (7.2°C) stock water delivered in Ritchie[®] waters. Days were categorized by daily high temperature: warm (>-3°C), cool (-9.5°C to -3°C), and cold days (< -9.5°C). Water temperature, daily high temperature and their interaction were evaluated and analyzed as a 2 x 3 factorial arrangement of treatments. Daily water intake per cow was affected by water and daily high temperatures ($P < 0.05$). Cows in warm water paddocks drank more (22.0 ± 1.1 L/d) than cows provided cold water (15.5 ± 1.1 L/d). On warm and cool days, cows drank more (avg 19.7 ± 1.1 L/d) than on cold days (15.5 ± 1.5 L/d). Cows in warm water paddocks came to water later ($P=0.005$) in the day on cold days (average 1303 hours) than cool or warm days. On any given day, thirty-six percent of cattle did not come to water. Water and air temperature during winter grazing affect drinking behavior.

0317

Collaborative Partnerships for Grassland and Prairie Habitat Restoration Projects with Aminopyralid

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Aminopyralid is a new herbicide developed by Dow AgroSciences for managing noxious and invasive plants in range/pasture and other non-cropland sites (such as wildlife openings, wildlife management areas, wildlife habitat, trails, and campgrounds). Registered under US EPA's Reduced Risk Pesticide Initiative, aminopyralid is a broadleaf herbicide with reduced risk to the environment compared with other available herbicides, making it desirable for invasive weed control. Aminopyralid controls over 60 herbaceous broadleaf plants including yellow starthistle (*Centaurea solstitialis*), Canada thistle (*Cirsium arvense*), and spotted knapweed (*Centaurea stoebe*). Aminopyralid effect on desirable native forbs and shrubs, replant interval of desirable species after treatment, and the impact on established or newly seeded grasses is considered by land managers when making decisions about controlling invasive plants. Research and demonstration projects were initiated with private land owners, university, local, State, and Federal Agency collaborators utilizing aminopyralid as a tool in integrated management programs designed to restore grasslands across diverse environments from the Pacific Northwest to the Southeastern US. Aminopyralid has been used successfully to control noxious and invasive weeds in sites that are being invaded and sites that have been highly degraded with weed invasions in order to re-establish a variety of cool- and warm--season, native and introduced grasses. In addition, land managers can use aminopyralid in restoration programs by controlling invasive plants while minimizing non-target plant (grass and forb) injury. With these non-industry partners, we are able to provide site-specific vegetation management prescriptions to better meet land manager objectives.

0318

To Graze or Not to Graze: Managing for Plant Diversity?

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Rangelands have traditionally been managed with moderate grazing primarily to provide the necessary forage resource for production of livestock sold in agricultural commodity markets for private benefit to the rangeland manager. Historically, the optimal management of these rangelands has focused on maintaining vegetation communities that best suit the seasonal grazing requirements of the livestock herds-typically, moderate stocking. These lands are being increasingly viewed as important providers of other goods and services valued by society, including a wide range of ecosystem services. However, as the demand for a wider range of ecosystem goods and services increase there may be pressure to change the vegetation communities across these rangelands by shifting management practices to the extremes (e.g. ungrazed, heavy grazing). Using results from studies conducted in the tallgrass and shortgrass prairies of the Great Plains, we will highlight how management changes (e.g. stocking rate, grazing system) may be implemented to meet the demand for goods and services that depend on altered plant community composition. The influence of these management changes on the economic and ecological productivity of subject rangelands will be discussed with a focus on the inherent tradeoffs. In addition, we will present what impact these changes in vegetation patterns will have on invasibility and rangeland productivity for livestock and other goods and services.

0319

Do Cultivation Land-Use Legacies Affect Rangeland Seeding Success?

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When the dry farming boom of the early 1910s buckled under pressure of falling wheat prices and drought, millions of acres of cultivated rangelands were abandoned. Natural recovery of the native plant cover on previously cultivated sagebrush ecosystems can take well over a century. Many of these abandoned farms were later reseeded with introduced grass species, like crested wheatgrass, in an attempt to improve forage production. We hypothesized that the cultivation legacy from dry farming inhibits the success of these seedings. To test this hypothesis, we compared perennial grass density and all plant species cover and composition in rangeland seedings that overlapped with previously dry farmed areas in two different ecological sites in northern Utah. We found patterned differences in grass density, cover, and species composition between seeded areas that were dry farmed, and those that had only been seeded. These results indicate that historical land uses such as dry farming can have a lasting impact on the success of future revegetation efforts. Unfortunately, the role of site history is rarely explicitly examined within the context of current management objectives for revegetation and restoration. Consequently, historical land uses, which are often unrecognized, could be limiting the management strategies that seek to alter the future trajectories of these landscapes.

0320

Predicting Potential Soil Aggregate Stability and Understanding Departure from Potential: A Climate-Soil-Vegetation Envelope Model Approach

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Conservation of soil and water resources in rangelands is a crucial step in stopping desertification processes. The formation of water-stable soil aggregates reduces soil erodibility and can increase infiltration capacity in many soils. Soil aggregate stability is highly variable at scales ranging from individual aggregates to bioclimatic regions due to complex interactions of soil texture, soil organic matter, soil organisms, vegetation and surface disturbance. Measurement of soil aggregate stability is a routine part of many national and regional monitoring and inventory efforts. Nearly all soils have some potential to form water stable aggregates. However, there are some systems where aggregate stability is nearly always high due to a combination of factors that provide a high level of resistance and resilience to degradation. In these situations, measuring soil aggregate stability as part of routine monitoring might not be necessary or cost effective. We utilize an extensive soil aggregate stability data set from across the western United States to quantitatively investigate the static and dynamic factors that govern soil aggregate stability. We use an envelope model approach to predict potential aggregate stability based on static properties including texture, landscape position, and climate. We then evaluate the mechanisms responsible for deviation from potential using dynamic plant and climate properties. Results demonstrate soil-climate-landscape combinations where soil aggregate stability is nearly always high, and situations where soil aggregate stability cannot be accurately predicted. The models developed in this study can provide guidance on when measurement of soil aggregate stability is necessary for understanding ecosystem processes.

0321

Farmers' Perception about Voisin Management Intensive Grazing and Ecosystem Services

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This study analyzes the perception of dairy farmers who adopted Voisin management intensive grazing (MIG) in relation to ecosystem services and wellbeing. MIG provides the cows with lush, nutritious grass for a limited amount of time until they are moved into a fresh pasture. This allows plants time to re-grow before they are re-grazed. Ecosystem services are benefits essential to society obtained from healthy environments. This study was carried out in Santa Catarina State, Brazil. Data came from 60 family farms scattered around 14 municipalities. Preliminary production results showed that after adopting MIG the average daily production improved 102%, productivity per cow increased 9%, the number of milking cows rose 11% and the number of heifers more than doubled 104.5%. All these indicators were statistically significant ($p= 0.00$). Also, after MIG adoption production costs dropped from 66 to 34%, labor time fell 50% and 67% of the interviewed farmers felt an increase in their quality of life. Among the environmental benefits of adopting MIG, 29% of the farmers reported improvements in water quality, 59% said that MIG decreased the animal access to the rivers due to appropriate fencing and 22% saw an increase in their riparian areas. Eighty seven percent perceived an increase in soil cover and 93% manifested enhancements in soil quality. These main findings show that MIG increases dairy production and the number of cows without significantly increasing the original pasture area. By protecting ecosystem structure, MIG restores essential ecosystem functions which enable the flow of ecosystem services.

0322

Hydrologic Vulnerability of Great Basin Sagebrush-Steppe Following Pinyon and Juniper Encroachment

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Extensive woodland encroachment into sagebrush-steppe has altered vegetation structure and hydrologic function of Great Basin rangelands. Tree encroachment elicits a vegetation pattern of tree dominance and spatially well-connected sparsely-covered intercanopy area. These changes coarsen the cover structure that, under pre-encroachment conditions, conserves water and soil. Similar transitions have occurred in the Desert Southwest with grassland-to-shrubland conversions and intercanopy vegetation degradation on persistent woodlands. Coarsening cover structure has been linked to amplified overland flow and soil erosion. We evaluated relationships in cover reductions and hydrologic response for multiple Great Basin sagebrush-steppe rangelands encroached by pinyon and juniper. Runoff and erosion from rainsplash, sheetwash, and concentrated flow processes were significantly greater from intercanopy than canopy areas across small- (0.5 m²) to large-plot (13 m²) scales. Runoff and erosion were dictated by the type and quantity of ground cover. Litter protected the soil surface from raindrop impact, provided rainfall storage, mitigated soil water repellency, and promoted aggregate stability. Surface runoff and sediment yield increased exponentially where bare soil and rock cover exceeded 50%. Sediment yield was linearly correlated with runoff, but varied among sites based on site-specific erodibility. Measured runoff and erosion rates suggest that while tree encroachment creates stable canopy patches, reduced shrub and herbaceous cover promote overall cover coarsening and amplify runoff and erosion across at least 30 m² areas. Results indicate overall hydrologic vulnerability of sagebrush-steppe following woodland encroachment depends on the potential influence of tree dominance on bare intercanopy expanse and connectivity and site-specific erodibility of intercanopy soils.

0323

Land-Use Legacies Affect Species Performance Nearly a Century after Cultivation

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A dry-farming boom swept across the western US in the early 1900s as Americans rushed to plow up sagebrush valleys and plant winter wheat. Within a decade, most of the dry farms failed leaving millions of acres of abandoned agricultural fields. This land-use legacy can still be seen in aerial photos and the cover and composition of vegetation within these old fields is different from surrounding non-cultivated areas. We hypothesized that the legacy of cultivation affected soil fertility, and that differences in soil fertility affect plant performance. To test this hypothesis, we compared N, P, Ca, Mg, and K levels inside and outside of these old fields in two different soils. In addition, we compared performance of an invasive grass (*Bromus tectorum* L.), two native grasses (*Elymus elymoides* [Raf.] Swezey and *Achnatherum hymenoides* [Roem. and Schult.] Barkworth), and a native forb (*Sphaeralcea grossulariifolia* [Hook. and Arn.] Rydb) grown in field-collected soils from two historically cultivated and non-cultivated areas in the greenhouse. Grasses generally performed better outside of historic cultivation but this affect was not consistent across both soil types. The native forb, *S. grossulariifolia*, had contrasting responses in and out of old fields that were dependent upon soil type. Potassium levels were higher in soils inside old fields and had a negative correlation with plant performance, suggesting that this nutrient most strongly affected plant performance. Our findings indicate that land-use legacies from dry farming can last for nearly a century.

0324

Ecophysiological Role of Leadplant (*Amorpha canescens*) in the Semi-Arid Grasslands of the Nebraska Sandhills

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Deeply-rooted shrubs are common components of many grassland ecosystems. This study investigated the ecophysiological role of leadplant (*Amorpha canescens*) on a sands ecological site at the Gudmundsen Sandhills Laboratory near Whitman, Nebraska. The predawn and midday water potentials of leadplant and 6 herbaceous species were measured using a pressure chamber (PMS Instrument, Albany, OR) at 2-week intervals from mid-June through mid-August 2010. The herbaceous species included 2 cool-season grasses [needleandthread (*Hesperostipa comata*) and prairie junegrass (*Koeleria macrantha*)], 2 warm-season grasses [sand bluestem (*Andropogon hallii*) and prairie sandreed (*Calamovilfa longifolia*)], and 2 forbs [western ragweed (*Ambrosia psilostachya*) and stiff sunflower (*Helianthus pauciflorus*)]. On each sampling date, measurements were taken of each of 5 randomly selected shrubs and of individuals of each of the 6 herbaceous species growing in the immediate vicinity of the shrub. And in a similar area free of leadplant, measurements were taken of each of the 6 herbaceous species in 5 randomly selected sites. The midday water potential of leadplant ranged from -1.15 to -2.8 MPa. The water potential of the herbaceous species ranged from -0.4 to -4.6 MPa, with the lowest water potentials recorded for cool-season grasses. Needleandthread and prairie junegrass tended to have less negative water potentials when growing in association with leadplant. Water potential of the other herbaceous species was not affected by the presence of leadplant. Preliminary results indicate that the presence of leadplant did not have a consistent effect on the water status of associated herbaceous plants.

0325

Using Similarity Indices as a Tool for Characterizing and Monitoring Vegetation within Prairie Dog Colonies in Southwestern South Dakota

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At the landscape level, prairie dog colonies contribute substantially to the heterogeneity of grassland ecosystems while serving as critical habitat for several listed and candidate endangered species. However, vegetation associated with prairie dog colonies is often described as early successional without addressing variation within and among colonies. We used Similarity Indices (SIs), as described by the Natural Resource Conservation Service state-and-transition models, to evaluate the spatial and temporal vegetation characteristics of prairie dog colonies in the Buffalo Gap National Grasslands of southwestern South Dakota. Thirteen prairie dog colonies were selected within Clayey (six colonies) and Loamy (seven colonies) Ecological Sites of the Western Great Plains Range and Irrigated Region-Pierre Shale Plains region (060A MLRA) and represented a range of ecological conditions. Colonies were sampled over a two year period (2009-2010) that included sampling select sites in both spring and summer within a year, and both years. Sample sites were stratified into interior, edge, and off-colony areas. Biomass and canopy cover of major species and plant functional groups were collected and used to generate SIs with respect to two reference plant communities (Historic Climax Plant Community and Buffalograss/Blue Grama Sod). SIs ranged from 8% to 76% relative to the Historic Climax Plant Community and 5% to 76% relative to the Buffalograss/Blue grama Sod Community. Considerable vegetation overlap was observed between reference plant communities when SIs were <25% for both communities. Spatial and temporal differences varied among colonies and were driven by a few major species and plant functional groups.

0326

A Conservation Partnership at Work in Western South Dakota

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Conservation partnerships are an effective method of addressing resource concerns at a watershed scale. The Belle Fourche River Watershed Partnership (BFRWP) is a group of local people and organizations that work together to coordinate available resources to address concerns associated with the Belle Fourche River Watershed. To date, much of their work has been centered around improving water quality by reducing total suspended solids (TSS) in the river. The four dominant land types in the watershed include farmland, both dryland and irrigated; forest land; municipal; and native rangelands. Native rangelands are by far the largest category covering approximately 74 percent of the watershed. Most of this land is privately owned and managed by livestock producers. The BFRWP has invested U.S. Environmental Protection Agency (EPA) 319 funds as part of an ongoing implementation project in the watershed to provide cost share on range riparian improvements practices and to provide technical assistance for ranchers developing improved grazing systems. In addition to the EPA 319 implementation project, the BFRWP was awarded a U.S. Department of Agriculture (USDA) Cooperative Conservation Partnership Initiative (CCPI) grant in 2009 that provides targeted Environmental Quality Incentive Program (EQIP) funds for range improvement practices in the watershed. In the past 5 years, the BFRWP enabled ranchers to treat over 400,000 acres of native rangelands in western South Dakota. The BFRWP's success has been through forming a strong relationship that communicates ideas between private agriculture producers; local, state, and federal agencies; and the general public.

0327

Restoration of Downy Brome Infested Rangelands with Glyphosate and Transplanting Wyoming Big Sagebrush to Increase Diversity

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As part of the USDA-ARS Area-wide project for invasive annual grasses, large-scale demonstration plots were established in 2009 to demonstrate and assess the effectiveness of reduced rates of glyphosate for control of downy brome and determine the utility of the treatments in stimulating establishment of desired species. An additional component of this research includes determining the survival of sagebrush transplants as related to plant source, site, planting year, and reduction of herbaceous competition. Study sites were established at each of 3 locations: (1) a cheatgrass monoculture, (2) a monoculture crested wheatgrass seeding, and (3) a native post-fire grass-forb community. At each site, treatments were arranged in a randomized block design with 5 replications. Each block included 8, 5 x 5m plots representing factorial combinations of herbicide treatment (glyphosate), no herbicide treatment, planting year, and plant source (wildling transplant or nursery stock), with 10 sagebrush planted in each plot. Interim (2009) results for the spring-planted trials showed that significantly more ($p < 0.05$) nursery stock survived than wildling transplants in each of the 3 plant communities where herbaceous cover was reduced with herbicide. In all plant communities combined, mean survival rate of nursery stock was 54.7%, compared with 16.7% for the wildling transplants. Surviving wildlings and nursery stock were significantly ($p < 0.05$) taller and hence more vigorous within each plant community in plots where herbaceous cover had been reduced with herbicide. The treatments detailed above were repeated during spring of 2010.

0328

Aminocyclopyrachlor: A New Herbicide for Pasture and Rangeland Weed Control

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Aminocyclopyrachlor, an exciting new class of auxin herbicide from Dupont, is under development for range, pasture and invasive weed control. In research trials conducted across the United States since 2005, aminocyclopyrachlor has demonstrated excellent activity on a number of important species such as thistles, leafy spurge, knapweeds, ironweed, and brush such as mesquite, and rubber rabbitbrush. Aminocyclopyrachlor has exhibited a number of positive stewardship attributes with very low impact to mammals and the environment.

0329

Survival and Growth of 8 Shrubs Transplanted into Amended Fluvial Mine Tailings

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Mine tailings have been fluviually deposited in riparian zones throughout the West. These areas of deposition are often completely devoid of vegetation and erosion of the tailings into streams and rivers impacts water quality. The most economical method of restoring these areas is to amend the tailings in situ to create a growth media that will support plant growth and then reestablish the native, riparian vegetation. The objective of this study was to evaluate survival and growth of 8 shrubs planted into mine tailings amended with lime and composted biosolids. In late June 2007, a site located along the Arkansas River south of Leadville, Colorado was amended and the following shrub species transplanted: gray alder (*Alnus incana*), silver sage (*Artemisia cana*), dwarf birch (*Betula nana*), redosier dogwood (*Cornus sericea*), golden currant (*Ribes aureum*), Booth's willow (*Salix boothii*), Drummond's willow (*Salix drummondiana*), and sandbar willow (*Salix exigua*). Dogwood did not survive and was replaced with shrubby cinquefoil (*Potentilla fruticosa*) in August 2008. In August 2009, golden currant had the highest survival at 89% and exhibited the most vigorous growth. Survival of shrubby cinquefoil averaged 86% after one growing season. Survival of Booth's, Drummond's, and sandbar willow averaged 16, 21, and 32%, respectively, while silver sage averaged only 5%. None of the alder or birch plants survived. Of the species evaluated, golden currant was the most promising shrub for restoration of amended mine tailings, but the young plants were very susceptible to herbivory by elk.

0330

Ecologically-Based Land Management on *Bromus tectorum* Invaded Great Basin Shrublands: An Ecosystem Assessment

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Demonstrating the merits of ecologically-based invasive plant management (EBIPM) for reducing *Bromus tectorum* (cheatgrass) at large, operational scales is an effective means to assist the adoption of this holistic framework. This framework helps managers identify ecological principles and processes responsible for plant invasions, and develop strategies that ultimately influence causes of succession, i.e., site availability, species availability, and species performance. We established two ~ 48-hectare demonstration sites in fall 2009 in northwestern Utah to evaluate the effectiveness of prescribed fire and pre-emergence herbicide to reduce cheatgrass abundance and facilitate the establishment of a diverse mix of grasses. We used a split-plot design with factorial arrangements of fire (whole plot factor, none or burn) and herbicide applied to 12-hectare plots (split plot factor, none or imazapic, 105 g ai/ha), with two replicates per site. Density of cheatgrass and the seeded grasses were sampled in spring and summer 2010. In the absence of fire, the herbicide treatment significantly reduced cheatgrass density by 41%. However, in burned plots, cheatgrass density was reduced by 58%, yet the herbicide treatment did not provide a significant level of additional cheatgrass reduction. The fire treatment also more than doubled seeded grass establishment. In the absence of fire, herbicide significantly reduced cheatgrass density, yet more so at the site where cheatgrass was most abundant. These results indicate that both fire and herbicide effectively reduce species availability of cheatgrass and improve species performance of seeded grasses. In addition, these results obtained at large scales corroborate with smaller-scale published results.

0331

The Impact of Livestock Grazing at State and National Scales on US Dryland Productivity at 1-km and 8-km Resolution from 1981 to 2009

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Mismanagement of grazing has been implicated in dryland degradation, yet the global extent of this phenomenon is unknown with an uncertainty range of 70%. To address this problem, we derived the forage available for grazing from 1-km Moderate Resolution Imaging Spectroradiometer (MODIS) net primary productivity (NPP) and 8-km Advanced Very High Resolution Radiometer annual summed normalized difference vegetation index (Σ NDVI) data for Texas and US rangelands from 1981 to 2009. We compensated for grazing impacts on the MODIS NPP algorithm by comparison of the NPP trend for National Wildlife Reserves by ecoregion to that of rangelands. We hypothesized that Reserves would have greater biomass than grazed areas and thus could be used to calibrate the grazed areas to maximum potential biomass. However, we observed that most rangelands had greater production than Reserves suggesting a grazing lawn effect on rangelands due to low to moderate levels of livestock grazing or a confirmation at the national-level of the observation that National Parks and Reserves were established on sites of low fertility and rugged terrain. This suggests a need for further stratification. We derived the forage required by livestock (cattle, sheep, and goats) at the county and State spatial scales from annual agricultural census records from 1981 – 2009. Hotspots (livestock appropriation of NPP = Forage available – Forage required), the areas impacted by livestock, were detected in 12% of Texas at the county scale, primarily in the panhandle, and 19% of the US at the state spatial scale, primarily in southwestern Arizona.

0332

Expiring CRP: Alternative Management Systems to Sustain Wildlife Habitat Values

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The Conservation Reserve Program (CRP) has provided valuable habitat for a variety of wildlife species and in doing so may have aided in stabilizing and or increasing populations of some species. Increases in the populations of some species of waterfowl and pheasants have provided many states an added economic stimulus due in part to the expenditures of sportspeople on land and room rentals, guides, and other outdoor related products. In recent years, numerous CRP contracts consisting of millions of hectares of grassland habitat have begun to expire with many more contracts scheduled to expire in upcoming years. Given the current market it is likely that many of these expiring CRP hectares will be returned to crop production potentially having a negative effect on wildlife species. However, it is likely that some landowners will search for management strategies that allow them to gain income off of the land, while maintaining habitat for the propagation and conservation of wildlife. The thought behind this symposium is to discuss some of the benefits CRP has provided certain wildlife species, dive lightly into the economics of expiring CRP land use, and to outline some potential management options that may provide for some agricultural outputs while continuing the propagation of wildlife species.

0333

Weed and Brush Management in Pasture and Rangeland with Aminocyclopyrachlor

James Harbour, Jeff Meredith, Eric Castner, Michael Edwards, Susan Rick, Craig Alford
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In research trials conducted in pasture and rangeland across the United States since 2005, aminocyclopyrachlor has demonstrated excellent activity on a number of important species such as thistles, leafy spurge, knapweeds, ironweed, and brush such as mesquite, and rubber rabbitbrush. Aminocyclopyrachlor has exhibited excellent weed control at low use rates and across a wide application window.

0334

Using Plant Functional Groups to Create Data-Driven State-and-Transition Models

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Ecosystem structure and function are both included in state and transition model concepts, but they are not always both addressed in model construction. We use plant functional groups to integrate a process-based understanding of ecosystem dynamics into data-driven state-and-transition models. We sampled 36 plots with different management histories on a mountain big sagebrush ecological site in northwestern Colorado. We measured plant species composition in each plot and categorized species into distinct functional groups as a proxy for a broad range of ecosystem functions. We identified potential states using hierarchical cluster analysis on plant species cover by functional group, and explored their relationship to site history using logistic regression. We found that some potential states based on functional group composition were related to management and disturbance history. Aerial spraying and wildfire within the past two decades predicted occurrence of shrublands dominated by snowberry, a re-sprouting shrub. Lack of disturbance was associated with high cover of non-resprouting shrubs, including mountain big sagebrush. Relationships between site history and potential states defined by functional groups appear to be related to those functional groups' responses to disturbance. These findings suggest that plant functional groups are a useful way to identify potential states and construct data-driven state and transition models.

0335

Quantifying Wildlife Habitat for State and Transition Models Developed in the Sagebrush-Steppe of Northwest Colorado

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We propose a simple, cost-effective method for including wildlife habitat information into state and transition (S-T) models. Netweaver software was used to develop fuzzy logic, empirical-based models to provide a quantitative indication of forage, cover, and overall (forage and cover integration) habitat quality for elk, mule deer, and sage grouse for states in alkali sagebrush-claypan (CP) and mountain big sagebrush- mountain loam (ML) ecological sites. Fuzzy logic provides a metric that describes the degree to which a variable belongs to a set and it can be used to build models for complex systems where parameters are defined by pre-existing knowledge. The information for these models came from peer-reviewed literature. Values were analyzed using a general linear mixed model in SAS (9.2). Integrating values across species and life stage by a limiting factor weighted average shows that reference states for both ecological sites have significantly ($p < 0.05$) higher forage values than degraded, eroded, or sprayed sites. Quality cover values are more associated with ML ecological sites. Within the ML site, the dense shrub state provides higher cover values than the reference state but there is a corresponding decrease in forage quality in this state. Our results indicate that for these species, managing for reference states is important on CP sites for forage quality and on ML sites for cover and forage quality. The inclusion of such information in ecological site S-T models increases the applicability of these tools to land managers. The habitat values are also input for an integrated ecological-economic model developed by our team to provide land managers with an indication of the costs and benefits of managing for quality wildlife habitat and other important ecosystem services.

0336

No-Till Interseeding Yellow-Flowered Alfalfa (*Medicago sativa* subsp. *falcata*) into Crested Wheatgrass (*Agropyron cristatum*) Stands: Initial Establishment

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Stands of crested wheatgrass (*Agropyron cristatum*) are common in the northern Great Plains. However, use of these stands for livestock production and provision of ecosystem goods and services is often limited because of low plant species diversity. Locally-adapted yellow-flowered alfalfa (*Medicago sativa* subsp. *falcata*) has been considered as a suitable forb species for complementing crested wheatgrass. A study was initiated in August 2008 to determine the feasibility of no-till interseeding yellow-flowered alfalfa into crested wheatgrass stands. Four locations were selected for this study: Newcastle, WY, Fruitdale, SD, Buffalo, SD, and Hettinger, ND. Three factors were evaluated at each location for two growing seasons: seeding date (late-summer vs. spring), sod suppression (1 L clethodim ha⁻¹ vs. untreated control), and seeding rate (0.56, 1.12, 3.36, 5.60, and 7.84 kg Pure Live Seed ha⁻¹). Dependent variables were seedling frequency, seedling height, and below canopy photosynthetically active radiation (PAR). Initial establishment of alfalfa interseeded in August 2009 and May 2010 was affected by precipitation, grasshoppers, and competition. Seedling frequency generally increased as seeding rate increased. Chemical sod suppression significantly ($P < 0.05$) increased seedling frequency, seedling height and below canopy PAR measurements compared to the untreated control. Crested wheatgrass canopy cover explained 95.5% of the variation in below canopy PAR measurements of the untreated control. Our results should be interpreted on the basis that initial alfalfa establishment is dynamic. Long-term success or failure is therefore difficult to determine at this time.

0337

Grazing Distribution Patterns of Beef Bulls and Cows During the Breeding Season in Central New Mexico

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Although cows have been tracked with global positioning system (GPS) technology in extensive rangelands, few studies have examined bull and cow movement patterns during the breeding season. Locations of 7 Angus bulls (2 to 4 years of age) and 14 of 110 mature Angus and Angus x Hereford cows were recorded every 10 minutes with GPS collars during a 64-day breeding season (mid May to mid July). Cows were tracked for 9 weeks in a 1601 ha pasture with one water source and 1 week in a 721 ha pasture with 2 water locations. Tracking data were successfully collected from the bulls for a minimum of 8 days and a maximum of 46 days. Slope use was similar for bulls ($3.47\% \pm 0.08$ SE) and cows ($3.55\% \pm 0.06$ SE). Mean distance from water for bulls was $1379 \text{ m} \pm 99$ SE, and it was $1639 \text{ m} \pm 51$ SE for cows. Bulls traveled $10.0 \text{ km} \cdot \text{day}^{-1} \pm 0.7$ SE, while cows traveled $7.0 \text{ km} \cdot \text{day}^{-1} \pm 0.2$ SE. Distance traveled by bulls per day varied among days of the breeding season ($P = 0.02$), but there was no consistent pattern during the season. Overall, bulls used similar areas of the pastures as cows and remained at water for only $5.8 \text{ hours} \cdot \text{day}^{-1} \pm 0.4$ SE.

0338

Accuracy of Cattle Grazing Distribution Patterns Recorded by Horseback Visual Observers During the Early Morning

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Global positioning system (GPS) technologies accurately record cattle grazing patterns in extensive pastures; however the number of animals that can be tracked is limited due to collar cost. Our objective was to evaluate accuracy of cattle grazing distribution patterns recorded by horseback visual observers that were simultaneously tracked with GPS collars. Locations of 6 mature cows within a herd of 110 cows were recorded every 10 minutes with GPS collars for 64 days during mid-May to mid-July in central New Mexico. Horseback observers recorded cow locations from 0630 to 0930 hours for 10 days. Elevation and slope of visually recorded positions were similar ($P > 0.50$) to GPS locations. Distance to water for visual observations was greater ($P < 0.01$) than GPS locations. Distance between visual locations and corresponding GPS locations varied among the 5 observers ($151 \text{ m} \pm 27 \text{ SE}$ to $772 \pm 128 \text{ SE}$). After removing data from the least accurate observer, distances to water of visual and GPS locations were similar ($P = 0.21$). Slope, elevation, and distance to water of early morning visual locations were similar ($P > 0.05$) to the mean of positions recorded from preceding evening (1900 hours) to the following mid-morning (1000 hours). Mean distance of GPS locations recorded during this 15-hour period was $408 \text{ m} \pm 32 \text{ SE}$ from the locations recorded during early morning. With sufficient training, locations recorded by horseback observers during the early morning can accurately estimate grazing movements of cows during their evening and morning grazing bouts.

0339

Improving the Credibility of State-and-Transition Models

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Ecological sites and state-transition models (STMs) have become an acceptable means of summarizing plant community dynamics on distinctive types of rangeland. Though STMs are generally affixed to an ecological site, they are usually developed solely from expert opinion rather than site-specific data due to a general lack thereof. However, if STMs are to gain credibility among users, there must be some level of data to back them up. We present three levels of data with STM development applications. The first level consists of photographs, GPS coordinates, rangeland health, production and step-point cover estimates for each state. Level one data is low cost, fast and easy to collect. It has applications in developing site-specific STMs, documenting existing states, hypothesizing drivers of state change and locating study locations for future research. The second level is similar to level one, but replaces production and cover estimates with multiple transects consisting of line-point intercept, double-sampling, and gap-intercept for each state. Level two data requires more time and training than level one, but yields more reliable and repeatable data conducive to statistical interpretations. Level three data seeks to identify the drivers of state change by quantifying ecological processes over space or time through controlled experiments, opportunistic studies or space for time substitutions. Level three data is expensive, time-consuming, and may not be necessary to gain the trust of STM users. Still, it is recommended for studies seeking to understand true drivers of state change. Each level has useful applications for improving the credibility of STMs.

0340

Experimental Comparison of Pre-Emergence Herbicides for Reducing Annual Grass Emergence in Two Great Basin, USA Soils

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Great Basin ecosystems have been severely impacted by the prolonged invasion of exotic annual grasses, the most notable being cheatgrass (*Bromus tectorum* L.). Incorporating the use of pre-emergence herbicides into a weed management plan provides a valuable tool to reduce annual grass dominance and improve the establishment of desirable species. However, herbicide efficacy on semiarid rangelands has been variable across ecological sites with differing soil types, often resulting in poor long-term control. We applied two herbicides, rimsulfuron (Matrix ®) and imazapic (Plateau ®), to two rangeland soils collected in sagebrush and salt desert ecosystems, and compared seedling emergence, growth, and survival of cheatgrass, crested wheatgrass (*Agropyron cristatum*), and bottlebrush squirreltail (*Elymus elymoides*) in a 30-d greenhouse experiment. Generally herbicides had similar effects on cheatgrass in both soils; however, rimsulfuron reduced both seedling emergence and growth, whereas imazapic reduced only seedling biomass, and allowed emergence. Herbicides also significantly reduced shoot growth of crested wheatgrass, but not the native bottlebrush squirreltail. These fundamental differences in herbicide impact of cheatgrass suggest that rimsulfuron will likely yield better pre-emergence control. In addition, variable injury to the perennial grasses is likely unavoidable, and herbicides should be applied post-emergence if crested wheatgrass is seeded. In practice, we advocate applying these herbicides in the summer, prior to cheatgrass germination, while postponing the seeding of revegetation grasses until late in the fall, when the likelihood of germination and injury is minimized.

0341

Successional Pathways of Wyoming Big Sagebrush Communities Historically Seeded with Crested Wheatgrass

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We sought to identify the factors responsible for potential community assemblages of 35 Wyoming big sagebrush communities historically seeded with crested wheatgrass. Species richness, diversity, vegetation cover, and soils were measured in four 20 x 5 m intensive Modified Whittaker plots per community. Hierarchical clustering analysis of indicator plant species cover identified that the 35 communities clustered in four distinct assemblages. Assemblage 1 was dominated by crested wheatgrass and had the lowest species richness and big sagebrush cover. Assemblages 2 and 3 had intermediate amounts of crested wheatgrass cover, but Assemblage 2 had higher native grass cover, but lower sagebrush cover than Assemblage 3. Assemblage 4 was dominated by big sagebrush and had the lowest cover of crested wheatgrass and other herbaceous species. The four assemblages also differed significantly ($P < 0.05$) for soil texture, soil nitrogen, and ground cover characteristics. Bare soil was nearly two-fold greater on loam-textured soils, and clay loam texture soils had higher rock and native plant cover. Communities previously cropped occurred on coarser textured soils, had six-fold lower native species cover, and two-fold greater exotic herbaceous and crested wheatgrass cover. Cropping occurred on favorable, non-rocky, fine textured soils, the same soils that favored crested wheatgrass cover and low recovery of native species. These results reveal a broader understanding of successional pathways and potential management opportunities, and may assist with developing resilience-based management models for communities with similar histories.

0342

The Ecology of Disturbed Ecosystems

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Revegetating disturbed ecosystems in the Intermountain West requires a fundamental understanding of key principles and processes that ultimately determine whether efforts end in success or failure. When disturbance regimes change substantially from the historical patterns required for native species to persist, invasive species often become dominants, and new ecological processes govern how lands yield ecosystem services including watershed capacity, agricultural productivity, and wildlife habitat. Managing within this context may best be accomplished through ecologically-based invasive plant management (EBIPM), a holistic framework that integrates ecosystem health assessment, knowledge of ecological processes, and adaptive management to form a step-by-step model. The core of this framework is a set of ecological principles that guide decision-making. We briefly introduce a set of disturbance principles that are linked to ecological processes, which not only affect the causes of plant community change, or succession, but also greatly assist applying tools and strategies for revegetation.

0343

Effect of Landform Position on Mesquite Growth Patterns

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Honey mesquite (*Prosopis glandulosa* Torr.) may provide a significant opportunity for supplying renewable feedstock for bioenergy production in the south central U.S. This research evaluated mesquite growth rates and stand characteristics during different stages of development to quantify site productivity and yield potential across different landforms. We assessed individual tree basal area, height, canopy coverage and age on the Smith Walker Research Ranch in Vernon, Texas. Comparisons were made relating structural characteristics and growth of virgin and regrowth tree type and stem density. Prediction of stand behavior and yield was analyzed observing individual tree behavior. Information obtained may lead to management practices never considered before on rangelands, which may include site management to optimize mesquite yield to produce a sustainable supply for bioenergy feedstock.

0344

Barriers to Collaborative Grazing Planning across Multiple Ownerships to Maintain Open Space and Wildlife Habitat in Washington Shrub-Steppe Ecosystems

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This case study examines a group of stakeholders and interested publics in Kittitas County who used the Coordinated Resource Management process to develop a grazing plan that would protect plant communities and improve forage quality for elk on a checkboard ownership landscape. This group's objective was to develop and implement a single, unified, scientifically sustainable grazing management plan with all of the landowners in the CRM boundary that would maintain or improve elk habitat. Rangeland technicians conducted a comprehensive survey of the area to ground truth soils data and prepare a grazing plan. Following completion of an Environmental Impact Statement for the public land that had not been grazed recently the Western Watersheds Project filed a lawsuit against the State. The utility company implemented the grazing plan as proposed and has installed range improvements to facilitate proper livestock distribution. The game department, having prepared a sound grazing plan and acting within their authority to implement it, now must wait for a civil judge to evaluate the merits of the applied science and make the final decision of whether to graze or not graze. Groups set to oppose grazing are opposed to grazing even when there is monitoring data and scientific background sufficient to prove that the grazing, as applied, is doing no harm. The social component of sustainability must be a primary focus when grazing livestock on public lands. Early and frequent communication with the most vociferous opponents may be an uncomfortable but necessary course of action prior to implementation.

0345

Woody Plant Encroachment Following Fire Suppression in the Kansas Flint Hills

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Changes in woody plant cover in Kansas Flint Hills tallgrass prairie were evaluated on various soil-topographic complexes using a series of 10 by 10 meter plots situated in areas from which fire had been excluded for from 15 to 75 years. Fifty-five years without burning resulted in woody plant encroachment exceeding 72 % cover on all soils, ranging from 56% on clayey uplands to 98% in lowlands and loamy rock outcrops of slopes. Grass cover on uplands decreased from 91% to 78%, declining to 18% in areas not burned for 75 years. Similarly, grass cover decreased from 78% to 13% on outcropping slopes and from 86% to 53% on non-outcropping slopes. In long-unburned areas (estimated at > 125 years), grass cover averaged 7% and 4% respectively. Grazing use of the soil-topographic complexes, subjectively measured, declined as total woody plant cover increased. Temporal changes in woody species composition varied by soil-topographic complex but generally were initially dominated by roughleaf dogwood (*Cornus drummondii*), coralberry (*Symphoricarpos orbiculatus*), and smooth sumac (*Rhus glabra*) with eastern redcedar (*Juniperus virginiana*) and some elm (*Ulmus spp*) dominating later seral communities. Slopes of long unburned wooded areas, with and without rock outcrops, were dominated largely by chinkapin oak (*Quercus muehlenbergii*) whereas those adjacent to streams or on lower slopes, were dominated by hackberry (*Celtis occidentalis*) and elm. These variations in encroachment rate and species composition of post-fire seral stages emphasize the importance of considering site-specific soil and topographic conditions when assessing land management issues.

0346

Recruiting Diverse Range Students for the 21st Century

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Publicly funded universities have struggled to maintain small and specialized programs to meet workforce demands for well-prepared rangeland management professionals. The Range Science Education Council has obtained funding to examine range curricula at the undergraduate level, but how do we bring students through our doors, or should we say 'portals'? This talk will summarize best practices from the college recruitment literature, including insights for diverse students and specialized science disciplines. Best practices include simple handouts pointing to well-designed websites, personal contacts, scholarships, and summer research opportunities. Students join degree programs because of promising careers. We will offer specific strategies for recruiting well-prepared students to undergraduate range programs based on what we have learned from a web-based survey of existing range students and students from allied fields nationwide.

0347

Fire Effects on Global CO₂ Emissions and Soil Carbon

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There is increased interest in the use of prescribed fires to restore degraded rangeland ecosystems, but information is needed concerning fire effects on ecosystem carbon emissions and sequestration, and how this might affect carbon mitigation policies. Fire initially releases CO₂ into the atmosphere and temporarily increases atmospheric CO₂ in the region of the fire. However, post-fire increases in vegetation leaf area and photosynthesis may off-set these initial increases in atmospheric CO₂ in many rangeland ecosystems. Regarding soil C responses, most rangeland fires have little initial effect on soil C loss. Some immediate gains in soil C may occur through increases in black or inert C from ash deposits. This paper will present data from research conducted in the southern Great Plains where woody plants such as mesquite (*Prosopis*) have invaded grasslands once dominated by C₄ midgrasses and prescribed fire is used as a management tool to reduce woody encroachment rates and shift grass species composition to more productive grasses. In these ecosystems, woody encroachment has increased total C stocks, although grass composition has degraded to less productive species. Prescribed fire typically increase grass production and grass root mass in shallow soil layers but decrease above ground mass from woody plants. Net effects on ecosystem C storage are poorly understood. Several examples of fire effects on C storage in different rangeland ecosystems will be presented.

0348

Recovery of Intermountain Grasslands with Fall Grazing or Rest

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Degraded mid elevation grasslands were switched from spring to spring grazing and recovery was compared with exclosures. Fall grazing was applied were to about 70 % utilization to determine if a switch in season of grazing alone could allow noticeable recovery. The grasslands are a mosaic of different plant associations including: Bluebunch wheatgrass/ Big sage (BBS), Big sage/Kentucky bluegrass (SKB), and mountain rough fescue (RF). Changes from 0 to 8 years are reported here. In BBS bluebunch wheatgrass cover increase similarly with fall grazing (+92%) or rest (+87%). Sandberg's bluegrass increased with fall grazing (+59%) but not with rest (+10%). Big sage increased more with rest (+113%) than with fall grazing (+76). In SKB, big sage increased with fall grazing (+87%) but much more so with rest (+188%). The cover of Kentucky bluegrass decreased with fall grazing (-87%) and rest (-72%). This was due to a drought event in the fourth year as well as increased competition from big sage in following years. In RF switching to fall grazing resulted in only a slight (+22%) increase in rough fescue cover while rest resulted in dramatically increased (+183%) cover. Cover of bluebunch wheatgrass with fall grazing (+78%) but didn't change with rest (-2%). Sandberg's bluegrass increased with fall grazing (+25%) but decreased with rest (-39%). Most species are dormant in the fall, so differing recovery with rest depends on litter accumulation. Rough fescue benefited most from litter accumulation.

0349

Novel Herbivores and Disturbance, Biotic Resistance, Community Structure, and Environmental Factors: Multi-Process Control over the Invasibility of North America's Endangered Wyoming Big Sagebrush Ecosystems

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Ecosystem invasibility is controlled by a causal network of factors and processes including: resistance of natives and non-native species to disturbance; biotic resistance; community structure; and propagule pressure. We conducted a study in *Bromus tectorum* invaded *Artemisia tridentata* ssp. *wyomingensis* communities. We sampled 75 sites spanning a wide range of factors predicted to be important determinants of community invasibility (cattle grazing disturbance, landscape orientation, soil physical properties). We found gradients of decreasing resilience and resistance evidenced by declines in native bunchgrasses and soil stability, increases in *B. tectorum* and bare soil, and shifts in community structure. These were associated with increasing cattle grazing, heat loads, and water stress. We identified three community states with significantly different composition and structure. Structural equation modeling assessed the relative importance of these factors and processes. Preliminary results show cattle trampling decreased soil biological crust abundance, which directly decreased biotic resistance and increased invasibility. We found no evidence that cattle increased *B. tectorum* propagule pressure, or that cattle grazing decreased invasibility by directly reducing *B. tectorum* abundance. Decreases in bunchgrass abundance by grazing, increases in sagebrush abundance, coarser textured soils, and heat stress increased the size of and connectivity between basal gaps in perennial vegetation. These shifts in community structure increased resource availability and invasibility. These findings provide important insight into the role of cattle grazing as a determinant of invasibility and place it in the context of the invasibility causal network. Absent restoration, fire may trigger a catastrophic regime shift converting 45% of our sites to *B. tectorum* grasslands.

0350

Fire and Post-fire Soil Erosion

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Erosion is a natural process that drives geomorphic change on rangelands. Soil erosion is affected by numerous variables controlling soil resistance to movement and the forces applied to the soil. Fire can interact strongly with many of the controlling factors, but affects erosion primarily through changes in vegetation structure and ground cover. Increasing completeness of combustion reduces impediments to wind and water surface flow and increases the probability of large erosion events. However, change in vegetation structure and cover after fire does not always translate into increased erosion. These changes have a passive role in determining erosivity, whereas storm duration and intensity play an active role and are unfortunately difficult to predict. The degree of change in vegetation structure and the duration of recovery after fire will affect the overall likelihood of excessive erosion. Timing of fire relative to the growing season and temporal distribution of rain and wind storms strongly affects erosion potential. Long-term fire exclusion may predispose a site to more severe and long lasting fire effects and increased likelihood of excessive erosion. Alternatively, approximating natural fire regimes ensures vegetation is capable of rapid recovery and should minimize exposure to destructive erosive events and excessive erosion.

0351

Use of Seed Agglomeration Technology for Enhancing Seedling Emergence in the Presence of Physical Soil Crust

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Vesicular soil crust decreases reseeding success in many semi-arid regions of the world. The objective of this study was to determine if seedling emergence could be improved by agglomerating multiple seeds into a single pellet, so that the seedlings from the pellet will generate sufficient force to penetrate the soil crust. Seed treatments were applied to bluebunch wheatgrass (*Pseudoroegneria spicata*) and crested wheatgrass (*Agropyron cristatum*). Agglomerations were formed using a rotary seed coater, in combination with a water sensitive polyvinyl alcohol binder and diatomaceous earth. Evaluations were conducted in the greenhouse, within a randomized block split-plot design, with five replications. Subplots consisted of 0.2 m² containers that were filled with either clay-loam or sand soil. Each container contained a factorial combination of the two species and three seed treatments: uncoated control, single seed coating and agglomeration coating. Starting seed density was constant across treatments. After seeding, 1.5 cm of water was applied using an oscillating-arm rainfall simulator, with an application intensity of 24.7 mm·hr⁻¹. Results indicate that early emergence of crested wheatgrass may minimize impacts from a rapidly forming soil crust. Coating treatments had no influence on crested wheatgrass seedling emergence. However, seedling density of bluebunch wheatgrass was at least 50 % higher with agglomeration relative to other seed treatments in the clay-loam, and both coating treatments were nearly double the control in the sand. These results indicate that seed coating improves bluebunch wheatgrass emergence in non-crusting soil, and agglomeration technology further enhances emergence in a crusting soil.

0352

Dryness and Desperate Measures: A Political Ecology of Ranching in the Rocky Mountain West

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Ranchers in the Rocky Mountain West navigate a complex land-tenure system comprised of deeded, leased, and public grazing lands. Severe droughts create management challenges for ranchers across their land holdings and impose physical, social, and economic impacts on the ranching system and rural communities. However, research remains ambiguous on how public-lands grazing affects ranchers' ability to cope with drought (Vásquez-Leon, West, and Finan 2003; Eakin and Conley 2002). And research specifically focusing on the relationship between land tenure and drought has thus far looked internationally (Liverman 1990, Western and Manzo 2003, Toni and Holanda Jr. 2008). Through semi-structured interviews with ranchers in northwest Colorado, northeast Utah, and southwest Wyoming, as well as Bureau of Land Management, U.S. Forest Service, and Farm Service Agency employees in the three states, this project explores the implications of land tenure on ranchers' drought coping and resilience. How does the land-tenure system in the Rocky Mountain West function during drought? How do ranchers' drought experiences and management strategies differ across land holdings? What role do institutions play? How adaptable is the system in the face of potential climatic changes? Results will also be considered within a broader political-ecology framework.

0353

Potential Native Species for Mitigating Fire and Weed Invasion

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Western water-limited sites left barren by large-scale fires or other disturbances are increasingly vulnerable to invasion by invasive plant species. Tackling the re-establishment or restoration of such sites is particularly challenging in areas of low and/or inconsistent precipitation. Do these sites have mixed establishment results due to restoration methods and techniques or do the seed mixes adequately represent the appropriate ecological site description? Within the Natural Resources Conservation Service Plant Materials Program, plant species are not chosen for the particular species but to solve or address specific conservation or ecological restoration problems. Utilizing the commonly understood ecological tenet that plants grow in habitats to which they are adapted, and accepting the corollary, if you change the habitat, so do the inhabitants change, may be the first in a twelve step process to select the appropriate native species and establishment techniques for the restoration of disturbed western landscapes.

0354

Deleterious Composition and Quality of Pronghorn Diets in Southern Arizona

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Fawn recruitment appears to be the main factor precipitating the decline of pronghorn (*Antilocapra americana*) populations in Arizona. Pronghorn biologists have recently speculated that nutritional deficiencies may contribute to poor recruitment. This study compared the diets of pronghorn in two game management units (GMUs) in southern Arizona; one location with chronically poor recruitment (GMU 36B), and one with higher recruitment (GMU 34B). The objectives of this study were to evaluate and compare the diet compositions, to evaluate and compare the diet qualities, and to perform nutrient analysis on forage for energy and protein values. We described diet composition using microhistological analysis of fecal samples corrected for differential digestibility during four biological periods (late gestation, parturition, peak lactation, and conception) over two years (2003 and 2004). Concurrently, we conducted nutrient analysis of composited diets yielding values for dry matter digestibility (DMD), digestible protein (DP), and metabolizable energy (ME). We used these data to evaluate the adequacy of the diet to meet protein and energy requirements during each biological period. We determined if significant differences existed in the diets between GMU 34B and 36B. GMU 34B had a significantly higher species richness both years (23.8 and 24.69 vs. 21.1 and 19.5, for 2003 and 2004 respectively). Forbs were the dominant forage class (62.7 to 97.2%) across all biological periods and years. Significant differences in diet composition were detected between years and GMUs. Dietary analysis confirmed protein and caloric intake in both locations were insufficient to meet nutritional requirements.

0355

Nutritive Value of Pasture Weeds in Oregon

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Forage quality was determined for fourteen weed species collected in western Oregon. Collection sites were randomly sampled for three consecutive years during spring, summer, and fall. Weed species analyzed included: bog rush (*Juncus effuses*), sedge (*Juncus spp*), spotted knapweed (*Centaurea maculosa Lam.*), diffuse knapweed (*Centaurea diffusa*), Scotch broom (*Cytisus scoparius L.*), French broom (*Cytisus monspessulanus*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), yellow starthistle (*Centaurea solstitialis L.*), meadow knapweed (*Centaurea pratensis*), gorse (*Ulex europaeus L.*), Himalaya blackberry (*Rubus armeniacus*), Portuguese broom (*Cytisus striatus*), and Italian thistle (*Carduus pycnocephalus L.*). Forage quality was quantified for the following plant developmental stages: rosette/vegetative, bolt, and early bloom/boot. Weeds were analyzed for crude protein (CP), acid detergent fiber, neutral detergent fiber, total digestible nutrients (TDN), and mineral content. For three weed species (French broom, bull thistle, and Italian thistle), CP content differed ($P < 0.01$) over the seasons, while TDN was not different. Nutritional value of weeds was compared to requirements of beef cattle, sheep, and goats throughout the production cycle. Quality was generally high, often meeting livestock protein and energy needs. Many weed nutrient profiles were similar to desirable forages. However, some weed mineral profiles indicated possible livestock health problems. Several weed species had high levels of potassium, calcium, magnesium, and copper at some stages of plant development. This information can be used to more accurately meet livestock nutritional needs while grazing weed species. Further research of weed species used as forage is needed to quantify anti-quality factors and palatability.

0356

Predicting Nutritive Value of Desert Bighorn Sheep Forage Using Near Infrared Spectroscopy

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The objective of this study was to develop near infrared spectroscopy (NIRS) calibrations for forage quality in desert bighorn sheep (*Ovis canadensis mexicana*) and to test a mobile laboratory concept. We used 576 samples of plants known to be consumed by desert bighorn, collected throughout their range in Arizona between 2002 to 2005. Spectra (325 to 2500 nm) were collected on dry ground samples. Forage quality was determined by traditional wet chemistry techniques for crude protein (CP), acid detergent (ADF) and neutral detergent (NDF) fiber. NIRS calibrations were developed by multiple regression techniques with 75% of samples and validated by simple regression with the remaining 25%. Calibration multiple coefficient of determination (RSQ) and standard error of cross validation (SECV) were 0.64;5.43, 0.73;5.43, and 0.73;5.43 for CP, ADF, and NDF respectively. Validation simple RSQ and SE of validation were 0.411;0.79, 0.58;14.57, and 0.58;19.78 for CP, ADF, and NDF respectively. Protein calibration results were less than expected. The inclusion of trees, shrubs and succulents along with the grass and forbs may have adverse affects on high quality calibrations. Fiber calibrations were deemed useful for initial forage quality determinations in a field lab setting. Further calibration development separated by plant type, i.e. grass, shrubs, forbs, trees and succulents may be necessary for accurate in-field predictions.

0357

Non-Fee Grazing Costs: Historical Review and Implications to Public Land Grazing Fees

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This presentation details the economic theory behind the comparisons of public and private land non-fee grazing costs, particularly as they relate to federal grazing fees and provides an historical overview of these costs. Items such as lost animals, labor, horses and vehicle use in activities such as moving livestock to and from grazing allotments and leased pastures and management while on the lease are critical in the comparison of public and private grazing costs. In 1966, the fee that would have equalized total public and private grazing costs was \$1.23/Animal Unit Month (AUM). Evidence from a 3 state study in 1992 indicates the equalization fee should have been \$0.13/AUM. Recent developments suggest that public land grazing costs may now exceed comparable private land grazing costs. We hypothesize that the cost structure has changed significantly since 1992, with substantial increases in vehicle operating costs, predation losses, increased herding, labor expenses and other factors, citing examples from around the western states.

0358

LANDFIRE Tools and Data Useful for Range Management: Explore the Past, Plan for the Future

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LANDFIRE, also known as the Landscape Fire and Resource Management Planning Tools Project, is a five-year, multi-partner project producing consistent and comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States. LANDFIRE products include tools and data that allow users to explore reference conditions, understand historic disturbance, assess ecological conditions and plan for the future across political boundaries within the United States. Here we will introduce LANDFIRE, illustrate potential uses, and demonstrate two key LANDFIRE tools, the Data Access Tool and the Fire Regime Condition Class Mapping Tool to help workshop participants imagine use on landscapes of interest. We will also discuss future project plans to improve or update the products with assistance from the field, limitations of the products, and methods to adapt or adjust the models and spatial data for local use.

0359

Effects of High-Density, Short-Duration Planned Livestock Grazing on Soil Carbon Sequestration Potentials in a Coastal California Mixed Grassland

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Planned grazing management in rangelands may improve carbon sequestration potential of soils by increasing plant biomass and the rate of nutrient cycling, which might mitigate global warming. The effects of high-intensity, short-duration planned grazing on several soil quality indicators (total nitrogen, organic carbon, labile and recalcitrant carbon, bulk density, plant species composition and percent vegetative cover) are being investigated on a non-irrigated coastal grassland in San Luis Obispo, CA. Sheep grazing was applied at two sites: a rangeland site previously rested from grazing for 40 years, and an adjacent site grazed for the previous six years. The objective of this study was to determine if planned grazing would change soil carbon levels on these sites. Data from the first year showed significantly higher soil organic carbon in samples collected from the grazed site, with an average of 0.60% more soil organic carbon at a depth of 0-3 cm when compared with the rested site. There was no difference in total nitrogen. Soil pH was significantly lower at the grazed site by an average of 0.63 at a depth of 0 to 3 cm, and 0.81 at a depth of 3 to 6 cm. We hypothesize that planned grazing at similar stock density, duration, and timing will improve soil physical, chemical, and biological indicators and increase soil carbon sequestration in the rested site. As rangelands cover 50% of the world's terrestrial surface, even a small increase in soil organic carbon could result in greater sequestration of excessive atmospheric carbon.

0360

Perceptions of Targeted Grazing in the Desert Southwest

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There has been increased interest in the possibility of using goats and sheep to control invasive species, yet few studies have considered using cattle to improve ecosystem services. We conducted focus groups and interviews with over 45 ranchers and natural resource professionals to assess land managers' perceptions of benefits of and barriers to targeted grazing (TG) with cattle as a way to improve wildlife habitat and reduce the risk of unwanted wildfires. We used an iterative coding process to analyze focus group and interview transcripts. We found that land managers had minimal prior knowledge about TG as defined by researchers. Once it was explained, most ranchers believed they had practiced TG in some form and saw its primary benefits as utilization of underutilized areas, control of specific species and restoration, while agency employees were more likely to cite improvement of wildlife habitat and fire mitigation. We found that ranchers in the desert southwest face real constraints to implementing and adopting TG practices as defined by researchers unless: 1) economic incentives are available to balance the additional time and labor invested in TG, 2) land management agencies provide the flexibility and support needed to implement TG practices, and 3) safety issues in border communities are resolved. We plan to use the results of this baseline study to design research that will assess ecological benefits of TG and to create outreach materials that address potential barriers to implementing TG.

0361

SRR Sustainable Ranch Management Assessment Project - Concepts, Goals, and Objectives

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Concepts. The Sustainable Rangelands Roundtable (SRR) is developing a program that marries the social, economic, and ecological aspects of ranch sustainability into a user friendly program that family ranches can use to evaluate their ranch business operations - using 17 indicators to track the progress of core ranch enterprises. **Goals.** Encourage interested ranchers to develop business plans and resource monitoring and management plans - using the 17 SRR developed indicators -- to assess whether or not a ranch business is sustainable over the long term. **Objectives.** 1. Urge family ranches develop a business plan that promotes the long term economic sustainability of their ranch. 2. Use science-based indicators and field protocols to measure changes in the social, economic, and ecological aspects of the ranch business. 3. Encourage the BLM, the USFS, and state land agencies to work with ranchers to develop joint monitoring programs on federal allotments. 4. Urge universities to develop outreach educational programs and technical and financial assistance for business planning and monitoring programs for ranch businesses. 5. Encourage ranchers to obtain detailed guidance and assistance as necessary to support the business planning and the monitoring processes from organizations such as NRCS, state and local agencies, universities, non-profit organizations, and private consultants including lawyers, accountants, and range consultants.

0362

SRR Legal, Educational and Institutional Assessment Indicators

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The Sustainable Rangeland Roundtable (SRR) has developed five criterion and 64 indicators that collectively may be used to determine whether U.S. rangelands are being used in a sustainable manner. Why use criteria and indicators to assess rangeland sustainability? Rangeland ecosystems are fragile and subject to wildfire, drought, climate change, invasive species, and conversion to other land uses such as subdivision development. Changes occur rapidly. Without monitoring and measuring affected processes, we cannot manage the land for long term sustainability. Ten indicators are included within the Legal, Institutional, and Economic Framework Criterion. Many of the indicators associated with this criterion represent abstract concepts to a far greater degree than indicators related to the other SRR criteria. The 10 indicators developed by the Framework Criterion Group portray the wide range of the factors that affect rangeland sustainability. A summary list of rangeland indicators developed by the Framework Criterion Group are as follows: 1) Land Law and Property Rights, 2) Institutions and Organizations, 3) Economic Policies and Practices, 4) Public Information and Public Participation, 5) Professional Education and Technical Assistance, 6) Land Management, 7) Land Planning, Assessment, and Policy Review, 8) Protection of Special Values, 9) Measuring and Monitoring and 10) Research and Development.

0363

Development of Most Similar Neighbor (MSN) Polygons for use with the Burning Risk Advisory Support System (BRASS) on Fort Hood, Texas

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Rangeland communities located on Fort Hood in central Texas are under constant threat of wildfire due to military training activities. In order to help manage and mitigate losses to life and property, a Burning Risk Advisory Support System (BRASS) is being developed to help decision makers understand fire risks, and model wildfire behavior. The BRASS system provides near-real time burning risk data derived using BEHAVE algorithms, and fire movement through a modification of FARSITE that utilizes custom fuel loads produced from the Phytomass Growth Simulator (PHYGROW). In this study, it was our aim to test our ability to model herbaceous fuel production on locations not previously sampled. In 2010, 39 of 180 long term sites were sampled, along with 39 (extrapolated) MSN sites. Herbaceous standing crop and litter were collected from ten, 0.25m² frames. ANOVA and Fisher's LSD were used to test for differences. MSN polygons were derived from: 1) vegetative cover from 10m SPOT Imagery, 2) woody vegetation polygons digitized from aerial imagery, 3) tank trails/roads layer, 4) ecological sites created from the SSURGO database, and 5) Fort Hood training area/land use polygons. Herbaceous standing fuel loads did not differ statistically between long-term sites (1836.60 kg/ha ±281.75), and MSN sites (1921.05 ±336.65 P=0.72), nor did litter (Long Term: 1815.03kg/ha ±374.84, MSN 1653.40 ±389.93, P=0.42). This suggests that our MSN polygons are sufficient at modeling remote-sensed areas with proper inputs. MSN may be a viable way to apply attributes to areas with remote sensing.

0364

Evaluation of Freeze-Thaw Dynamics in Hummocked Wetlands

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Hummocks in riparian and wetland areas are relatively small mounds that create uneven ground. The presence of hummocks is often used as an indicator of degraded riparian or wetland condition which influences land use management. However, this assumption may or may not be valid and more information is needed concerning hummock formation. Hummock formation processes are not well understood but one predominant theory for formation is differential frost heave. This theory relies on the coincidence of freezing temperatures and standing water in the interspaces. The objective of this study was to evaluate the temperature regimes in hummocks and interspaces along with presence of water and freezing air temperatures. Four hummocked wetland sites in North-central Colorado were selected for sampling. At each site, four monitoring locations were randomly selected. Each monitoring location was equipped with soil temperature sensors in the interspace, at the base of the hummock and at 2/3rds of the height of the hummock. A water sensor was used to determine when there was standing water in the interspace. An air temperature sensor was placed at each site. These sensors were connected to loggers programmed to record hourly data. The temperature for October through December at the top of the hummock was colder and more variable (Mean=1.3°C, SD=4.1) than the hummock base and interspace (Mean=1.9°C, 2.3°C, SD=3.6, 3.4, respectively). Results indicate the coincidence of standing water in the interspace, freezing air temperatures and unfrozen hummocks, suggesting that freeze-thaw processes may be related to hummock formation and maintenance.

0365

Understory Cover in Relation to One Seed Juniper Sapling Stand Structure at a Site in New Mexico

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Overstory-understory interactions have been extensively studied in mature juniper woodlands, but little is known about these interactions during the sapling stage of juniper encroachment. We determined herbaceous understory cover, and sapling dimensions and density, from 177 VLSA (very large scale aerial) photos systematically arranged on a 150 x 600-m grid covering an area of approximately 3,500 acres at the Corona Range and Livestock Research Center in central New Mexico. The survey area included three soil associations, elevations ranging from 1,784 to 1,967 m, and slopes between 0 and 8%. Photo-location distance from water and roads ranged from 16 to 3,599 m and 1 to 1,460 m, respectively. The area is managed for mule deer and antelope pronghorn habitat and is moderately grazed by livestock year-round. Twenty-three juniper sapling- and environment-related predictors of understory cover were included in the analysis. The best model ($C_p=9.01$; R^2 0.4; $P<0.01$) included size (crown diameter) of focal sapling, distance to first and second closest neighbor, size of first and second closest neighbor, vegetation type, elevation, slope, and distance from water. Our results suggest that sparse stands with > 2 m between small saplings (< 1 -m crown diameter) may facilitate an increase in understory herbaceous cover at this site. Conversely, stands with < 2 m between individuals, or large saplings (>2.5 m-crown diameter) may be associated with decreasing understory cover. We conclude that there is a forage-production benefit derived from sparse stands of small saplings and a forage loss to larger or denser stands.

0366

Moving Beyond the Myths and Traditions of Fire Behavior in Rangelands

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A wide array of social practices and ecological services in rangelands rely on a detailed understanding of fire behavior. Choosing effective fire suppression tactics, safely conducting and controlling prescribed fires, and understanding how fire influences plants, animals, nutrients, hydrology, and human activities all hinge upon the degree to which we can characterize fire behavior and apply that knowledge in practice. This is particularly important in modern resource management. Wildfires are globally increasing in size, frequency, and severity in human populated environments, prescribed fires are being conducted in some regions in wildfire-type conditions, and numerous ecosystem-level models and policies have been created that simplify fire behavior and its role in shaping ecosystem dynamics. As a result, researchers and practitioners must move beyond the long-established myths and traditions of fire in rangelands that were created by searching for general, correlative linkages among fuels, weather, topography, fire behavior, and fire effects. While this type of approach has enhanced our understanding of fire in rangelands, current and future management objectives demand a more robust, mechanistic interpretation of rangeland fire behavior. Here we present empirical and theoretical research from post-grassland Ashe juniper and mesquite woodlands that illustrate how a mechanistic framework can move the field beyond traditional generalizations in fire science and application. We highlight how this approach provides a quantitative link that spans theoretical and applied domains, thereby connecting scientists and landowners, and how it may prove useful in the future study, design, and creation of state-and-transition models in rangelands.

0367

Tebuthiuron Role in Rangeland Restoration Programs

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Tebuthiuron is an herbicide used over the past 3 decades to facilitate western US rangelands restoration. Depending on rate applied, tebuthiuron can selectively control woody plants, grasses, and herbaceous broadleaf invasive plants. Tebuthiuron use rate range is 0.56 to 4.4 kg active ingredient per hectare. Woody species controlled include post, blackjack, and sand shinnery oaks, creosote bush, tarbush, sagebrush, whitebrush, and others. Grass and forb species will recover following release from competition with woody plants controlled with tebuthiuron. Dry formulations of tebuthiuron (20 % pellet and 80% dry flowable formulations) preclude drift and minimize off-site movement. Tebuthiuron formulations disintegrate with rainfall, move into the soil where root uptake occurs, and is then translocated to plant stems and leaves where it inhibits photosynthesis. Woody plant response is slow and death occurs after carbohydrate reserves are exhausted. The herbicide is particularly effective in arid and semi-arid environments where erratic rainfall and weather conditions often reduce reliability of foliar-applied herbicides. In Great Plains grasslands tebuthiuron can be used to rapidly shift species composition by controlling exotic cool-season grasses and releasing native remnant warm-season grasses. Tebuthiuron reliably provides a high degree of root kill of target woody plants and herbaceous plants with a single application, rapidly alters plant successional trajectory, facilitates recovery of desirable herbaceous species, and extends duration of plant control. Beneficial effects of plant control with tebuthiuron have been observed to persist for more than 10 years in high rainfall environments and much longer in semi-arid and arid environments.

0368

Understory Responses to a Mixed-Severity Wildfire in Ponderosa Pine Forests of the Black Hills, USA

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In late summer 2000, 34,000 ha of ponderosa pine forests in the Black Hills of South Dakota burned in the Jasper Fire. This was a mixed-severity wildfire resulting in a mosaic of areas burned at low- (25%), moderate- (48%) and high-severity (27%). We examined changes in understory structure (relative abundance of graminoids, forbs and shrubs) and species composition relative to fire severity (unburned, low, moderate and high) 5 and 10 years post fire. We estimated understory canopy cover by species using an extended Daubenmire frame (50 x 100 cm) at 36, randomly selected sites. Twelve plots were systematically located at each site. We also conducted an extensive search (presence/absence) for invasive plants at each site. Five years post fire, understory structure of low-severity and unburned sites were similar, species composition differed. Forbs were most abundant in moderate- and high-severity sites. Canopy cover of exotics increased with increasing fire severity, however noxious species accounted for <5% of exotic species cover there. Ten years post fire, understory structure of low-severity and unburned sites are still similar, except for a slight increase in the relative abundance of graminoids in the low-severity areas. Common juniper, snowberry, and Oregon grape are significantly more abundant in the low-severity sites relative to the high- and moderate-severity sites. Invasive species (Canada thistle and hounds tongue) are more abundant in the high-severity sites.

0369

Fine-Scale Observations of Soil Properties in Hummocks and Adjacent Interspaces

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Hummocks in riparian areas and wetlands are relatively small mounds (< 1 m in diameter and height) that create uneven ground. According to the scientific literature, differential frost heave is the most widely accepted theory of hummock genesis. However, most of the published work on hummocks comes from the physical sciences. Interestingly, no theory of hummock formation in recent review papers includes large ungulate activity as an important factor. But, the management literature in natural resources often suggests that hummocks are an indicator of degraded riparian or wetland conditions caused by large ungulate trailing and trampling (most often attributed to domestic livestock). As a side investigation in a study of hummocked wetlands, we collected slabs of soil from two hummocks and adjacent interspaces for detailed analysis. Slabs were 5-8 cm thick, excavated to a depth of ~30 cm and included an entire hummock and the adjacent interspace. A 5-cm grid was constructed on each slab and soil samples from each cell in the grids were collected for determination of soil texture, bulk density, nitrogen, total carbon, organic- and inorganic-carbon. Soil properties from different regions of the hummocks and interspaces were then compared. Nitrogen and organic C were highest near the soil surface. There were not consistent differences in bulk density between hummocks and interspaces, and soil texture was fairly consistent. Based on these observations, it does not appear that hummocks result from compaction of the interspaces, but may still be related to the activities of large ungulates.

0370

A Matter of Ecological Context: The Response of Tallgrass Prairie Butterflies to Fire

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In ecosystems that have rarely experienced fire during evolutionary time, many species are fire-sensitive, i.e., they suffer high mortality due to fire. However, even in fire-prone ecosystems, some species appear to be fire-sensitive. The presence of these species is an interesting conundrum. Did these fire-sensitive species persist in fire-prone ecosystems due to population processes, e.g. recolonization permitted by metapopulation structure? Or were historical fire frequencies actually much lower than previously thought? Multiple tallgrass prairie butterfly species have been shown to be fire-sensitive, and their fire-sensitivity has been used to infer that fire was an infrequent process in tallgrass prairie. Here, we synthesize findings on the responses of tallgrass prairie butterflies to fire at multiple sites across three states: Missouri, Kansas, and Iowa. Effects of fire varied greatly among species, but also within species. Butterfly populations responded very differently to pyric herbivory (the ecological interaction of fire and grazing) than to fire alone. Sensitivity to fire appears to be mediated by multiple factors, including species traits (especially dispersal ability), sampling period, extent of fire, grazing intensity, and proximity to unburned habitat. After comparing our findings with those from other studies, we propose that the responses of fire-sensitive species to fire are highly context-dependent. For rangeland managers, we provide some general recommendations for managing fire-sensitive species in a variety of ecological contexts.

0371

Using Images to Evaluate the Relationship Between Habitat Characteristics and Sage-Grouse Lek Counts

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Knowledge of habitat conditions is essential to understanding the effects of management activities and disturbances on sagebrush (*Artemisia* spp.)-dependent species. Current sagebrush-habitat inventory methods are labor intensive, therefore expensive, resulting in limited inventory actually conducted, and management decisions made with inadequate data. Development of new technologies such as high-resolution aerial photography are providing less expensive inventory methods and may result in more frequent data collection that could display trends in sage-grouse (*Centrocercus* spp.) habitat conditions. A number of studies have sought to understand the habitat conditions that promote sage-grouse populations. Our study was initiated to evaluate habitat conditions within a 3.2-km radius of known leks and relate lek-area habitat conditions to lek counts. Ground and aerial digital images were acquired in June 2010 over 514 km² of the upper Powder River watershed encompassing Casper Creek, Wallace Creek, and their tributaries and associated streams and uplands in Natrona County, Wyoming. Aerial images were systematically-acquired with nested resolutions of 1-, 10-, and 20-mm ground sample distance over 3228 planned locations; plus, additional aerial images were acquired in rapid-succession bursts where aerial transects crossed riparian areas. Ground images were acquired from 1 m above ground level with sub-millimeter resolution at 960 aerial-image locations. The study area contains 9 groupings of leks available for analyses. We used ARCMAP to identify aerial samples falling within lek analysis regions, indicating the aerial-sample base for each lek grouping ranged between 198 and 350 evenly-spaced and fully distributed images, not including the riparian bursts and ground images.

0372

A Comparison of Stream Morphology and Vegetation of Cottonwood-Dominated and Open Reaches within a Riparian Ecological Site in NW Colorado

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Land managers in northwestern Colorado have identified that riparian areas are more important than uplands for the ecology, management, and economics of local ranches. We compare stream morphology and vegetation of 30-m reaches with and without cottonwoods (open vs. closed canopy) on two adjacent streams (Elkhead and Calf Creeks) to determine whether they are alternate states. Reach morphology was characterized using Rosgen stream classification based on slope, sinuosity, entrenchment, width, depth and channel bed composition. Vegetation cover by species was measured in each hydrologically unique component (near-stream vs. far). Reaches were found to be Rosgen type B, C, or E, with entrenchment the greatest variable. Ordination shows that the strongest differences in species composition were related to canopy cover and stream. Open canopy near-stream components were characterized by high cover of smooth brome, while closed canopies had willows and young cottonwoods. Elkhead Creek has a near-stream component characterized by sedges and rushes, while the near-stream component in Calf Creek has upland species. This appears to be a function of the streams' differing morphology, including greater entrenchment on Calf Creek. This pilot study suggests that while vegetation of riparian areas differs according to canopy cover, the largest differences in both morphology and vegetation are between the two streams themselves, even though they are adjacent and have similar management. This finding represents the challenge for generalizing the effects of management across multiple streams. Sampling on a larger scale might reduce variation between streams and aid in the development of alternate riparian states.

0373

Patch Size Controls Selectivity of Sheep Grazing Grass-Clover Grasslands

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The trophic interaction between ruminants and grasslands is a fundamental process that shapes landscapes and modulates ecosystem function and productivity. Selective grazing can structure plant communities and thus, the control of selectivity can be used for ecosystems management. We hypothesized that selectivity for clover by sheep can be modulated by changing the degree of interspersions between grass and clover patches. We built 34 x 17 m pastures and modified their vegetation by seeding subclover and using selective broadleaf and grass herbicides to create either four 8.5 x 17 m rectangles or seventeen 2 x 17 m bands dominated by grass or clover. Pastures were grazed in the spring with either four sheep for 12 days or 12 sheep during four days. We measured herbage mass before and after grazing, and observed activity (grazing or other) and location (grass or clover) from 6 AM to 8 PM and determined selectivity as the ratio of total sheep-hours grazing clover divided by sheep-hours grazing grass. Sheep grazed more time in clover than in grass, particularly in the large patches than in the bands ($P=0.025$, 2.9 vs. 1.4). We did not detect a significant difference due to number of sheep or interaction, but the test had low power due to small sample size. Herbage mass changes also reflected a strong preference for clover, particularly in large patches. These results provide further evidence to the literature that indicates that vegetation pattern can be used as a management factor to modulate plant-animal interactions.

0374

Geographic Variation in Crown Structure and Foliage Biomass of Woodland Trees across the Great Basin

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The woodland portion of the Joint fire Sciences Funded SageSTEP (Sagebrush Treatment and Evaluation Project) has collected tree data from plots covering a range of tree dominance levels on 13 sites extending from southeastern Oregon southwest through California, Idaho and Nevada to Western Utah. These data have been supplemented with compatible data from four additional Great Basin sites. Each tree species present on a site has a close relationship between its total crown area and its total foliage biomass across the plots for each site. The slopes of these relationships differ significantly across the Great Basin. For both juniper and pinyon species they are the lowest in Utah and generally increase to the north and west with the highest slopes for juniper in Oregon. These differences are shown to be the result of trees of a given crown diameter being the shortest in Utah and generally increasing in height to the north and west. Foliage biomass and one-hour fuels follow the same pattern with a four meter crown diameter juniper in Oregon having up to nearly twice the foliage biomass of a four meter crown diameter juniper in Utah. The reverse is true for tree height with a five meter tall juniper in Utah having up to over twice the foliage biomass as a five meter tall western juniper in Oregon. These results have implications for differences in fuel loads, fire patterns, carbon sequestration and carbon cycling in woodlands across the Great Basin.

0375

Patterns of Woodland Overstory/Understory Successional Changes over a Central Nevada Elevational Gradient

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In response to climatic and anthropogenic factors, Great Basin plant communities have changed over centuries and decades. Since settlement of the Great Basin about 140 years ago, singleleaf pinyon and Utah juniper have increased in area, density, and dominance, encroaching into adjacent sagebrush communities. Tree density and biomass increases are resulting in declining understory plant communities, and more intense fire behavior as fuel loads from the trees increase. The purpose of this study is to quantify changes in plant community composition, biomass, and fuel loads associated with increases in tree dominance over an elevational gradient in central Nevada. Successional changes in the plant community components are compared on the basis of their foliage biomass changes over the successional gradient from no trees to maximum tree foliage biomass. Increasing tree dominance differentially affects the shrub, grass and forb components of the understory community. The shrubs and deep-rooted perennial grasses are the most affected by the increasing tree dominance, reaching minimum levels of foliage biomass 2/3 to 3/4 of the way through succession. Total forb biomass has a minimal overall decline until the shrubs and deep-rooted perennial grasses reach their minimal foliage biomass levels and then rapidly decline. The point in the sere where the shrubs and deep-rooted perennial grasses reach their minimum foliage biomass levels appears to be a threshold. Here the dynamics of the remaining understory community changes, as does the response of the site to disturbance by fire.

0376

Pastures of Deserted Animal Industries of Uzbekistan

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The 17.5 million hectares of pasture in Uzbekistan are concentrated within three ecological zones: sandy (9 million ha), sagebrush-ephemeral to desert and foothill zones (7.2 million ha), Ache to semi-desert (1.3 million ha). At the same time, about 3.0 million hectares of pasture is unsuitable for operations owing to the degradation of cover and a shortage of water. Deserted pastures are exposed to several factors including: overgrazing (44%); vegetation destruction (25%); infringement of vegetative cover (1%); plowing (5%); reduction of water sources (15%); and the approach of mobile sand (10%). Under the influence of these factors the following consequences have been observed: an exposure of the soil surface, the degradation of separate pasture sites, and the formation of mobile sand. Biological efficiency of pastures and their fodder capacity decreases as a result, which is necessary to consider as the beginning of the process of desertification. At the irrational use of pastures in a sandy zone of Kizilkum, the specific structure was reduced by 4 times, by 2 times for bushes and semi bushes, and by 2.5 times for edible fodder plants. The increased feeding capacity, expansion of specific structure of pasture, and creation of insurance stocks of forages will expand the possibilities of use for arid territories. The technologies for the creation of forest shelter belts and for the creation of different function (pasture, haying) and use terms (spring-summer, fall-winter, all year) have been developed.

0377

Crossings, Corridors and Trophic Cascades: Wolves and Woody Vegetation in Banff National Park

Clifford A. White

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In the early 1900s, removal of native peoples, predator control, and re-introduction of elk resulted in high ungulate densities in the Bow Valley of Banff National Park. High ungulate herbivory rates resulted in the nearly no regeneration of aspen to heights above 2m by the late 1930s, and in concert with ongoing fire suppression, led to numerous other changes in long-term patterns of tree, shrub, and wildlife habitat distribution patterns. The issue remained a focus of research and management for several decades, becoming more critical when aspen regeneration continued to fail after prescribed burning began in the 1980s. Wolves recolonized the Bow Valley in 1985, assisted by construction of wildlife fences and crossing structures across the Trans Canada Highway, and establishment of wildlife corridors and habitat patches around the communities of Lake Louise, Banff, and Canmore. From 1985 to 2005, elk densities through most of the valley declined by 90%, largely due to wolf predation, but also other actions such as culling human-habituated elk near the Town of Banff. The cover and height of almost all woody plant species increased in a spatial pattern inverse to elk densities. Recent prescribed burns accelerate regeneration of native shrubs, possibly by creating dense deadfall patches avoided by predation-averse ungulates. Although populations of several large ungulates declined during the initial wolf recolonization period (when both elk and wolf densities were high), trophic cascade and spatially-variable fire effects may maintain important wildlife habitat for numerous species including moose, deer, beaver, and several birds.

0378

Restoring Native Tallgrass Prairie and Improving Profitability on Eastern South Dakota Grasslands with Intensive Early Stocking

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Cow-calf producers in eastern South Dakota often over-winter calves to take advantage of the low cost gain associated with lightweight cattle on grass to improve profit margins. Season-Long Stocking (SL) however, has converted the majority of native grassland to a mix of introduced cool-season species which has reduced production efficiency and biodiversity. Intensive Early Stocking (IES) may address both of these issues by improving production and economic efficiency through improved gain per acre and reducing resource competition for native warm-season species. The objective of this study was to determine gain per acre, return per acre, and species composition change of IES vs. SL. Two sites were established in May of 2010 in Miller, SD and Volga, SD. Study sites were predominately smooth brome and Kentucky bluegrass pasture. At both sites, yearling steers (327 kg) were grazed SL at the recommended stocking rate for 120 days. The IES treatment was grazed at twice the recommended stocking rate for 60 days. All cattle were weighed prior to grazing, at 60 days, and following grazing. Forage yield was measured weekly throughout the grazing season. Gain per acre and return per acre were calculated following the end of the trial. Species composition was sampled in May and September. Gain per acre was similar between the IES and SL treatments; however, there was an increased trend in native warm season grass composition on the IES treatment.

0379

CRP...A Duck's Best Friend

Bob Sanders

Ducks Unlimited, Montana, United States

Few programs have done more for North America's waterfowl than the Conservation Reserve Program. With over 3 million acres of grasslands enrolled in Montana, CRP is arguably one of the most important tools for long term conservation of grasslands and our wildlife resource. This presentation will highlight the value of grasslands and wetlands for breeding waterfowl and the role CRP plays on Montana's landscape.

0380

Establishment of Invasive Species in Post-Fire Seeding Treatments

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Post-fire reseeding in semi-arid shrublands in the Intermountain West and Great Basin is intended to reduce weed reentry. However, few studies adequately address impacts of seeding methods on establishment of undesired species. Native sagebrush (*Artemisia tridentata* spp. *wyomingensis* and *Artemisia nova*) in Box Elder County, Utah succumbed to the Scooby Wildfire in August 2008. We collected biomass at the Scooby Wildfire site the second summer after post-fire rehabilitation seedings to test the hypothesis that the presence of exotics would differ depending on seeding method. Seeding treatments were designed to compare seeding methods using a rangeland drill which covered seed with a chain, and a minimum till rangeland drill which pressed seed into the soil with a billion packer. Biomass samples of invasive species (*Halogeton glomeratus*, *Salsola kali*, and *Bromus tectorum*), seeded native grasses, and both volunteer and seeded forbs were collected in four replicate blocks of the different seeding treatments by clipping four randomly placed 0.25 m² subplots. Analysis of Variance (ANOVA) for a randomized block design (RBD) was used to identify biomass differences. Total biomass did not differ among treatments; values ranged from 120 to 236 g/m². Total exotic biomass among nine treatments (as a percent of total biomass) was greater in all controls (unseeded, rangeland drill 0 seed, and minimum till 0 seed) than in other treatments, $P = 0.0075$. Limiting the return of undesired species is critical to long-term success of wildfire rehabilitation.

0381

Alberta's Wolf Report: Quantifying the Impacts

Callum Sears

Flying E Ranche, Stavelly, Alberta, Canada

In 2007, the need to document and quantify the damage caused by wolves in southwestern Alberta became apparent. Ranches where wolves had never been seen before suddenly had numerous attacks. Combine this increase in wolf activity with Fish and Wildlife's resistance to act on the damage caused by wolves, and ranchers desperately needed some ammunition. The Wolf Report is a seven-question survey conducted over 22 outfits for the years 2007 and 2008. The survey covered not only confirmed kills, but also damaged animals, unconfirmed wolf kills, veterinarian costs, missing cattle, additional management days, and shrink. While this study did not consider effects on reproductive rates and herd health, it still found that confirmed kills on those 22 ranches represented less than 1/5 of the costs that were actually incurred. Under the current management strategy, or lack thereof, the wolf problems are only going to continue to worsen. The time is now for every realistic user of North America's wilderness, whether it be for pleasure or for a living, to come together and stand up to foolish policies put in place by misguided souls.

0382

Wildfire as a Process in Riparian Recovery and Stability

Clayton B. Marlow

Montana State University, Bozeman, MT, United States

Most lotic riparian areas experience more frequent and often more severe disturbances than neighboring forest, shrub and grassland systems. Without reach-level disturbances like flooding, channel avulsion, deposition and erosion soil development eventually drives ecological succession to replace riparian vegetation with community types analogous to those in surrounding uplands. Therefore, the long term presence of riparian areas largely depends on recurring patterns of seasonal, annual and decadal stream discharge. These patterns, in turn, are modified by the areal extent, severity and return interval of wildfire. Even riparian areas burn on occasion; the affect of fire on the composition and age structure of woody vegetation in the watershed ultimately determines the renewal and sustainability of riparian features within the landscape. Removal of small trees reduces the interception of precipitation and reduces the demand on shallow groundwater levels. Freed to move downslope this water augments annual discharge and elevates late season flows which maintains the suite of processes that support riparian areas. Recent reports of higher discharge and extended stream flow in drainages with extensive bark beetle damage furthers the argument that the density of woody species can affect riparian processes. This inter-relationship suggests that riparian form and function depend on and reflect the periodicity and scale of wildfire in the watershed.

0383

Using Social Media (BLOGS, Facebook, & Twitter) for Extending Range Livestock Information

John Harper

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Social media such as internet based blogs, facebook and twitter when linked with RSS feeds provide a new tool for disseminating range livestock information to a growing group of both traditional producers and the general public. This poster will focus on both the technology, methods and some of the results of using this new technology within Cooperative Extension programming.

0384

Improvement in Ecological Status with Grazing Management and Range Chiseling

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Rangeland chiseling has been used by many ranchers to improve production on clubmoss or blue grama dominated rangelands in the Great Plains and Rocky Mountain valleys. Two chiseling trials along with deferred grazing, were evaluated to assess the effect of rangeland chiseling & managed grazing on plant communities. In November of 2005 and March of 2006, a replicated chiseling trial was done on the CB ranch of southwest Montana. The replicated trial compared fall vs. spring chiseling vs. deferred grazing. The plant community was about 20% similar to potential with a 70% basal cover of clubmoss. In March of 2002 a range chiseling was done on the Schott ranch, southcentral Montana. The plant community was 25% similar to potential consisting of blue grama, clubmoss, western wheatgrass, etc. The CB ranch spring chiseling returned \$3.60 more than the control, the Schott chiseling \$2.00 more. An ANOVA was used to evaluate the treatment effects on the CB ranch. Bluebunch wheatgrass production was 50% greater than the control with fall chiseling and 88% greater with spring chiseling ($P=0.05$). The Similarity Index improved from 20% to 41% with deferral on the control (more than doubling the stocking rate), from 20% to 57% on the fall chisel (more than doubling the stocking rate), and from 20% to 70% on the spring chisel (four fold increase in stocking rate in four years). Spring chiseling appeared to be more effective, bluebunch wheatgrass is still increasing relative to the controls, and grazing management improves production significantly. Ecological values and economic returns are improved substantially with grazing management alone and especially with chiseling plus grazing management.

0385

Forest Service and Defenders of Wildlife Team Up to Implement Non-Lethal Control of Prairie Dogs

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US Forest Service Wall RD, Wall, SD, United States

During the summer of 2006 and 2007, the US Forest Service - Buffalo Gap National Grassland - Wall Ranger District and the Defenders of Wildlife teamed up to implement a non-lethal method for prairie dog control on areas adjacent to private land. The method used was installation of temporary electric fence along a half-mile boundary management zone (BMZ) in grazing allotments adjacent to private land. The goal was to prohibit livestock grazing in the BMZ, essentially rest from livestock grazing, thus increasing vegetative structure and creating a vegetative barrier to reduce the movement of prairie dogs. The Defenders of Wildlife purchased and donated the materials needed to install 12.5 miles of electric fence. The Wall Ranger District has selected the sites, and installed, maintained, removed and stored the electric fence over the past five years. Sites suitable for this non-lethal method of prairie dog control have been evaluated and fences installed on an annual basis beginning in the spring of 2006, and each year thereafter including 2010. A protocol was established in 2007 using Visual Obstruction Readings and Daubenmire plant canopy cover plots to monitor vegetative response and prairie dog acres have been GPS'd annually. The data collected over a three period (2007-2009) shows that fencing and resting BMZ areas from grazing has significantly reduced prairie dog re-colonization of these particular sites compared with areas not fenced and treated with rodenticide.

0386

Very-High Resolution Imaging for Resources Monitoring

D. Terrance Booth

USDA-ARS, Cheyenne, WY, United States

The Society's Rangeland Assessment and Monitoring, and Remote Sensing & GIS committees have organized this symposium to discuss the technology and applications of very-high resolution (VHR) digital imagery for all aspects of rangeland management including assessments of ground cover, riparian condition, wildlife habitat, woodlands and other resource concerns. The presentations cover the state of the science for acquiring, analyzing, and using ground- and aerially-obtained images; and, illustrate why and how this technology can make rangeland sampling more economical and provide for sampling densities and distributions that will test management questions with less risk of false conclusions. To help users gain the full benefit of the new technology, the symposium includes four presentations on statistical considerations of VHR image-based sampling. Some VHR image users require full image coverage. Five presentations relate to the creation of mosaics and other VHR-image manipulations. Two presentations discuss new platforms that promise to influence aerial acquisition methods. The several presentations on applications give evidence of VHR-image utility for a variety of rangeland ecosystems. Questions remain, more progress is needed; but, much of the technology has moved from research to application-application that will provide land managers greater confidence in condition-and-trend, and effectiveness-monitoring assessments, and a more successful means for supporting management decisions at the watershed or landscape level. We open the symposium with keynote speakers whose experience in remote sensing and rangeland-monitoring needs provide the science background; we close with dynamic individuals to summarize the applications to current monitoring efforts and the implications for future research.

0387

Low-Cost Camera Modifications and Methodologies for Very-High-Resolution Digital Images

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¹USDA-ARS, Beltsville, MD, United States, ²FalconScan LLC, Greenbelt, MD, United States, ³USGS, Reston, VA, United States

Aerial color and color-infrared photography are usually acquired at high altitude so the ground resolution of the photographs is < 1 m. Moreover, current color-infrared cameras and manned aircraft flight time are expensive, so the objective is the development of alternative methods for obtaining very-large-scale-aerial (VLSA) images. We describe a new method for acquiring digital color-infrared photographs for monitoring vegetation from Unmanned Aerial Systems (UAS). A red-light blocking filter is placed in front of the lens of a 12-megapixel digital camera, which does not have an internal filter that blocks near-infrared (NIR) light. The result is a camera that acquires photographs with NIR, green, and blue bands. We compared images from the camera and a digital color camera over different grass species at the NRCS Beltsville Plant Materials Center. Small UAS with color-infrared cameras could provide low-cost imagery for sampling allotments at critical times with rapid delivery of information to the user.

0389

Business Planning Concepts and Methods - How Does it Work?

Cindy Garretson-Weibel

Wyoming Business Council, Cheyenne, Wyoming, United States

Many ranchers typically think that a business plan consists primarily of their financial statements. And while the financial plan is an important component, there are many other elements necessary to have a complete business plan. This session will discuss the various components of a business plan and how a business plan can be used as a road map to make decisions for the entire ranching operation. Regardless of the exact format used to develop a business plan, several key areas should be addressed: business concept and structure, market analysis and plan, management plan, financial plan, and break-even analysis. Some agricultural businesses may also require a design and development section, a manufacturing plan for products, or an operations plan for a service business. If the business plan is going to be read by potential investors or lenders, an executive summary should be included as well as proposed funding information, and an appendix of supporting materials. These components will be explored during this presentation. Evaluating the current ranch operation and potential income is an important concept that will be discussed. Assessing the potential of the entire ranch resources means gathering information that will help pinpoint weaknesses in the existing operation and identify new opportunities. Utilizing a holistic approach to managing the ranching operation includes evaluating the human resource at the core of the operation, including individual values, goals, knowledge, skills, interests, and abilities. It expands to include all of the other ranch resources.

0390

The Business Planning Process and Incorporation of Monitoring Information

Cindy Garretson-Weibel

Wyoming Business Council, Cheyenne, Wyoming, United States

This session will expand upon the previous session: Business Planning Concepts and Methods - How Does it Work? The primary components of a business plan and how a business plan can be used as a road map to make decisions for the entire ranching operation will be discussed. In addition, the presenter will demonstrate that rangeland monitoring data is an important component of the entire business planning process. A resource inventory is also an important component of the business plan and will assist the rancher anticipate any problems that may exist, and identify opportunities for better utilizing current resources. Completing a natural resource assessment will help identify the land manager's awareness of the role of natural resources in the current ranching operation, and monitoring will provide further data useful in making sound business decisions. Many ranchers have already incorporated rangeland and resource monitoring into their ranching operations. This session will further explain how these planning tools can be incorporated into the ranch business plan and why there is a need to do so.

0391

Integration of Herbicides into Wildlife Habitat Restoration Programs in Southwestern Rangelands

D. Chad Cummings, Robert Masters, Greg Alpers, Vernon Langston
Dow AgroSciences LLC, Indianapolis, IN, United States

Sand shiner oak (*Quercus havardii*), post-black jack oak (*Quercus stellata x marilandica*), sandsage (*Artemisia filifolia*), and honey mesquite (*Prosopis juliflora*) are four native woody plants common to the southwestern rangelands, and are important habitat features for many wildlife species including the lesser prairie chicken. Decades of over-grazing and climate change have shifted many semi-arid and arid rangeland sites to woodlands dominated by sand sage, shiner oak, mesquite or other woody species. The herbicides, tebuthiuron, triclopyr, and clopyralid can be used to provide the targeted vegetation management required to optimize wildlife habitat restoration. Triclopyr plus clopyralid (280 to 560 g ae/ha triclopyr + 280 to 560 g ae/ha clopyralid) have been standards for mesquite control in the southwest for more than 20 years. Tebuthiuron offers residual control of several woody species. Tebuthiuron use rates can range from 1.1 to 2.2 kg ai/ha depending on land management objectives and plant species to control. With the help of state and federal government agencies, private land holders, and special interest groups, the integration of herbicides into wildlife habitat programs have led to conversion of over 400,000 ha of degraded woodland into restored wildlife habitat in New Mexico. Additional success stories can be found across the southwest where chemical, mechanical, and cultural restoration tools, including prescribed fire, are applied in the appropriate combinations and sequences to result in successful habitat restoration.

0392

A Historical Perspective of Native Plants for the Restoration of Disturbed Landscapes

John M. Englert¹, Jack R. Carlson², W. Curtis Sharp³, Douglas Helms¹

¹USDA-NRCS, Washington, D.C., United States, ²USDA-NRCS (Retired), Fort Collins, CO, United States,

³USDA-NRCS (Retired), Harpers Ferry, WV, United States

Human-induced changes on the landscape of the United States over the past 200 years continue to impact how land managers address significant natural resource issues such as soil erosion, water quality, and the control of noxious weeds. Federal and state supported efforts to evaluate plants to stabilize and restore disturbed landscapes date back to the 1880s. The Soil Conservation Service (SCS), created by Congress in 1935, established soil conservation nurseries to evaluate and produce large quantities of plants, both native and introduced, for large-scale restoration projects. Increased use of native grasses arose as the nurseries (later called Plant Materials Centers) refined methods for producing seed and replanting, and with public interest in using native species for revegetation projects. Today, the Natural Resources Conservation Service (NRCS, formerly the SCS) and its Plant Materials Centers are at the forefront of selecting and promoting a wide range of native plants for natural resource conservation efforts. NRCS, Agricultural Research Service, Forest Service, Bureau of Land Management, many other state and local organizations, and commercial growers have a concerted effort underway to continue and accelerate the mission to return our disturbed lands back into productive ecosystems.

0393

Plant and Animal Responses to Targeted Grazing of White Locoweed in New Mexico

Laura Jacobson, Andres Cibils, David Graham, Lyndi Owensby, Wendy Taylor, Kirk McDaniel
New Mexico State University, Las Cruces, NM, United States

Targeted grazing with small ruminants has been used effectively to control a number of noxious forbs on rangelands. We hypothesized that intermittent targeted grazing with sheep would suppress white locoweed (*Oxytropis sericea*) while allowing sheep to avoid detrimental effects of ingesting locoweed alkaloids. Twelve 200m² locoweed infested plots received one of the following treatments: 1) Control (no treatment); 2) Picloram +2,4-D (positive control); 3) Targeted grazing with sheep which grazed on locoweed plots for 5 days followed by 3 days on locoweed free plots (intermittent grazing, ITG); and 4) Targeted grazing with sheep which grazed locoweed infested plots throughout the experiment season (non-intermittent, NITG). Herbicide was applied at the beginning of the study in 2009 whereas grazing treatments were applied in spring 2009 and 2010. Plant and animal responses were measured prior to treatment, immediately post-treatment (except herbicide), and at the end of 2009 and 2010 growing seasons. Preliminary data analysis from 2009 showed that targeted grazing and herbicide were similarly effective in reducing locoweed canopy cover, biomass, and number of flowering heads ($P \geq 0.05$); however, density of locoweed plants was significantly reduced by herbicide but not by grazing ($P < 0.01$). Serum thyroxine levels suggested that ITG ewes were less affected by locoweed alkaloids than NITG ewes ($P < 0.01$). We anticipate that 2010 season results (which will also be reported in our talk) will confirm these trends. Our preliminary findings suggest that intermittent targeted grazing with sheep could be used to suppress locoweed on rangelands while avoiding detrimental effects of alkaloids on animals.

0394

Monitoring Groundwater-Dependent Ecosystems on National Forest Service Lands

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Groundwater-dependent ecosystems (GDEs) include regionally and nationally significant ecosystems such as springs, many wetlands (all fens), caves, and numerous riparian areas. On National Forest System lands, an approach for consistently identifying, characterizing, and monitoring GDEs is needed to effectively manage these resources. A Technical Guide is being developed to meet this need. The guide will present protocol options for different levels of data collection, depending on objectives and priorities, available resources, and scales of interest. Level I will be primarily completed in the office, with limited field work. Existing information will be used to describe GDE type, location, extent, current uses, physiographic and geologic setting, and general ecological conditions. Level II includes all Level I information, and also describes field methods to inventory and monitor springs, fens and other wetlands, with focus on measurement of hydrology, soil, geology, and vegetation variables. Level III will present a conceptual framework for defining Environmental Water Requirements for GDEs. Preliminary results from field testing of the draft protocol in Colorado will be presented. Although GDEs comprise a small percentage of the land area managed by the Forest Service, they provide valued ecosystem services, including clean water and habitat for numerous rare species; their conservation and sustainable management are high priorities. With new demands on water resources and predicted scarcity of water due to energy development and climate change, GDEs are increasingly threatened. This guide seeks to provide a consistent, scientifically sound, and realistic approach to characterizing and monitoring groundwater dependent resources.

0395

Distribution of a Rare Sand Dune Legume Limited by Deer Herbivory at Multiple Scales

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Hairy prairie clover (*Dalea villosa*) is a perennial legume of sand dunes and sandy soils across the Great Plains from Texas to Saskatchewan. This plant is considered threatened under the Canadian Species at Risk Act, and herbivory is identified as a potential threat to the species. However, there are many unknowns about this threat, in particular the identity of the herbivores, the impact of herbivory on demography of the plant, and distribution of this herbivory in time and space. Between 2007 and 2010, we used a combination of manipulated experiments, descriptive investigations, and field observations to address the outstanding questions on the largest known population of plants in Canada. Using infrared triggered digital cameras we identified both mule and white-tailed deer as the primary visitors to patches of hairy prairie clover that experienced herbivory over the growing season. Three years of monitoring a cohort of 200 adult plants, half of which were excluded from herbivory, indicated that herbivory was reducing reproductive output by 47 to 59% annually, but had no effect on mortality of plants. Thus, herbivory may have few short-term consequences on persistence of this legume that reproduces both vegetatively and by seedling recruitment. However, a reduction in seed production and seedling recruitment may limit long-term persistence and potential for colonization in these patchy sand dune habitats. Occupancy surveys of 421 habitat patches, and estimates of herbivory in 172 occupied patches, indicate a landscape pattern that may be related to hunting pressure on deer populations in the 200 km² study area.

0396

Characterization of the Thermal Environment of Rangeland Pastures with Heterogeneous Vegetation Structure

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Thermoregulation needs constrain feeding site selection patterns of rangeland-raised livestock. Cattle at our research site select woodland or grassland feeding sites in apparent response to changing weather conditions. This study characterized the thermal environment of pastures containing woodland/grassland mosaics at a site in central NM. A network of 8 weather stations was used to record air temperature, relative humidity, wind direction and velocity in grassland swales (GS) and ridges (GR), and closed (CW) and open (OW) piñon- juniper woodlands ($\geq 45\%$ and $\leq 30\%$ tree cover, respectively) in two contiguous ~300-acre pastures. Data were gathered at 15-min intervals during 12 and 14 days in 7/09 (summer) and 4/10 (spring), respectively. Daily average wind chill factor (WCF) and temperature-humidity heat index (HI) were developed to calculate percent days with predicted thermal comfort (PTC) conditions for beef cattle ($WCF > 32^\circ\text{F}$; $HI < 68^\circ\text{F}$) in each vegetation type. During spring, OW and CW offered the lowest (62%) and highest (86%) percent days with PTC conditions, whereas GS and GR had PTC conditions on 79% of days. During summer, GR and OW had PTC conditions 58% of the time, whereas GS and CW had PTC conditions 50% and 42% of the time, respectively. Lack of temporal synchrony of micro-meteorological conditions among vegetation types caused entire pastures to offer areas with PTC conditions more often than each of its vegetation types considered individually. Vegetation structure heterogeneity within pastures appears to improve the availability of grazing sites with PTC conditions during spring and summer at this site.

0397

Selling Conservation to Get Producer Buy-In

Justin Meissner

USDA-NRCS, Townsend, Montana, United States

We were able to promote Sage Grouse Conservation by developing a plan that was based on mutual gain by developing a relationship based on trust and respect. To do this we worked with area ranchers outside of the standard programs and assisted with day to day ranch activities when the opportunity arose. We are able to share our experience of working on multiple ranches to show what worked and what did not work. Our focus was identifying all resource concerns and developing alternatives PRIOR to any discussion about program activities or cost share. By giving these ranches an UN-biased inventory of their operation and making suggestions on things they might consider to improve their bottom-line, they in turn were willing to listen to how these changes were going to improve sage grouse habitat. Of the ranches inventoried all but two took ownership of the plan and agreed to participate in the special initiative. There are now additional ranches located within the core area that are interested in participating and are currently being inventoried.

0398

Making Good Things Happen - Working on the Ground with the Landowner

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¹Rancher, Raynesford, Montana, United States, ²USDA-NRCS, Stanford, Montana, United States

Working with people, landowners, farmers or ranchers really isn't a lot different than communicating with anyone. You must be honest, sincere and willing to spend time with the cooperator to understand how things work on their land and in their operation. The cooperator must be equally as honest and sincere, open-minded to new ideas, and willing to share the knowledge they have gained operating their land with the agency person. When done right, both individuals will learn from each other and good things will happen on the land for years to come.

0399

Watershed Restoration Committee for the Upper Clark Fork River

John Hollenback

Rancher, Gold Creek, Montana, United States

The Watershed Restoration Committee for the Upper Clark River (WRC) has been able to acquire funds to improve rangeland and riparian areas. The WRC has installed over 30 miles of pipelines and installed over 35 stock tanks on a gravity system to pull livestock off of riparian areas. They have also installed windmills and solar pumps throughout the watershed. The WRC has helped ranchers with funding to control problem weeds and encouraged ranchers to improve their grazing management. The WRC has sponsored a Stewardship Program with the US Forest Service on 40,000 acres that is infested with the pine bark beetle - this also involves 14 additional environmental groups. The WRC board consists of nine members and two employees.

0400

Aboriginal Burning and Keystone Predation: A New Paradigm for Range Management

Charles Kay

Utah State University, Logan, UT, United States

Aboriginal-ignition rates were 300 to 35,000 times greater than known lightning-ignition rates in the United States. By repeatedly firing the vegetation, Native Americans created ecosystems heretofore thought to have been "untouched by the hand of man." The reason woody vegetation has invaded rangelands throughout the world is because aboriginal burning has been eliminated. Fire should not be thought of as a treatment, but as an integral and necessary component of rangelands. In addition, native hunters kept large mammal populations well below what the habitat would support. There were no grazing systems. Instead, most ecosystems were predator-limited and aboriginal people were the ultimate keystone predator. In 1491, there were not 60 million bison, 10 million elk, or 100,000 grizzlies, and flocks of passenger pigeons did not darken the sky. Wildlife populations irrupted to unnatural levels only after the American Holocaust decimated native populations up to 150 years, or more, before actual European contact.

0401

Will Super Juniper-Eating Sires Produce Super Juniper-Eating Offspring?

Kendall Tidwell¹, Cody Scott¹, Charles Taylor³, John Walker², Dan Waldron², Corey Owens¹, Micheal Salisbury¹

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Sire selection is typically used to improve production characteristics of livestock. However, the effect of genetic selection for diet preferences is unknown. Over the past 100 years, the encroachment of redberry (*Juniperus pinchotii*) and ashe (*Juniperus ashei*) juniper has reduced herbaceous forage production on rangelands in the southwestern U.S. Recent efforts focused on using goats as a biological method of control for juniper encroachment. Goats will develop a preference for juniper and consume juniper throughout the year after conditioning in the pen. Similarly, divergent genetic selection has been shown to increase juniper consumption by goats. The objective of this study is to determine if sire selection for juniper consumption will improve acceptance of juniper by offspring from a group of randomly selected doe. Five billies selected for juniper consumption and five other billies selected for production characteristics were bred to 7 does each (n= 70). Kids were weaned at 90 days of age and placed in individual pens and fed juniper for 14 days. Consumption of juniper was measured and compared between treatments and among sire groups to determine if sire selection for juniper consumption improves acceptance of juniper by offspring. In addition weight gain, structural correctness, and loin eye area were measured. Intake and performance data will be presented.

0402

Mesquite Seedling Disappearance Under Goat Browsing

Landon Pyle, Cody Scott, Corey Owens
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Honey mesquite (*Prosopis glandulosa*) is an invasive shrub species that is widespread throughout the southwestern U.S. Mechanical and chemical control efforts can reduce mesquite cover but are expensive with limited longevity of control. Biological control of mesquite is difficult because toxic agents within the plant limit intake. Goats can effectively reduce the amount of viable seeds spread across rangelands because they disperse few viable seeds. The objective of this study was to determine if goats could control mesquite from the seedling stage and determine whether or not repeated defoliation would lessen seedling survivability. Two trials were conducted. In the first trial, 4 pastures (24-28 hectares) were utilized. Two pastures served as control (no goats) and two were stocked at a moderate stocking rate with goats. Seedlings (n=40) were germinated in a greenhouse and randomly transplanted to two 10x10 m plots per pasture (5 seedlings per plot). Each plot was monitored twice weekly for nine weeks for seedling mortality. For the second trial, mesquite seedlings were defoliated at different frequencies (0, 1, 2, or 3 times) in a greenhouse with mortality and growth (above and below ground) recorded. There were no differences ($P>0.05$) in seedling disappearance between treatments in the pasture study. In the greenhouse study, root mass was higher ($P<0.05$) for seedlings that were not defoliated. However, above ground mass and mortality were similar among treatments. We contend that biological control of mesquite at the seedling stage by goats is not an effective control method.

0403

Effects of Bitterweed Ingestion on Reproduction in Rambouillet Rams

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Bitterweed (*Hymenoxys odorata* DC) is a toxic plant common to central Texas and is known to cause chronic, sub-acute and acute toxicosis in sheep. However, little is known of bitterweed's effect on reproduction in sheep. This study was conducted to determine if bitterweed ingestion delayed puberty or affected sperm production in yearling Rambouillet rams. Twenty-five rams were used and randomly allocated into either the bitterweed treatment or the control treatment. The bitterweed treatment was dosed with ground bitterweed (0.2% BW) for 3 days via oral gavage. Intake of a novel food (rolled barley) was paired with dosing with bitterweed to assess toxicosis. Rams also received a feedlot ration (2% BW) to meet maintenance requirements. Serum metabolite levels were also monitored initially and every 24 hrs thereafter to assess soft tissue damage from toxicosis. Bitterweed toxicosis caused reduced intake of rolled barley, the feedlot ration, and elevated serum metabolite levels, but seemed to not impact puberty or sperm production. In addition, one ram died from bitterweed toxicosis after two days of dosing. Semen color, motility, and concentration were similar ($P>0.05$) between treatments. The control treatment maintained intake and serum metabolite levels remained within the normal levels while serum metabolite levels were elevated above the normal range healthy animals for rams dosed with bitterweed. While bitterweed ingestion does result in toxicosis, it does not appear to affect reproductive development in yearling Rambouillet rams.

0404

An Overview of Lentic Wetlands

Mary Manning

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Lentic, or standing water wetlands, have attributes that distinguish them from lotic, or running water riparian systems. The unique interaction of the vegetation, soils/substrate and hydrology creates various types of lentic systems. This presentation will address the various attributes common to all lentic wetlands, along with the unique attributes of the different types of lentic systems. Other presentations in this session will go into more detail on various lentic systems and their associated characteristics. Types of lentic wetlands include springs, wet meadows, peatlands, marshes and swamps.

0406

Impact of Wetland Restoration on Forage Productivity of Prairie Pothole Wetlands

Etienne Soulodre

Saskatchewan Watershed Authority, Regina, Saskatchewan, Canada

Wetland restoration is a land management practice being promoted on tame pastures in the aspen parkland region of Saskatchewan. While this practice is widely promoted to promote wildlife habitat and water quality, little is known about the impact of this practice on forage productivity. In Saskatchewan, we have two projects evaluating the impact of wetland restoration on forage production. The first is located in the Smith Creek watershed. Here, forage productivity of 6000 lbs/acre of dry matter was measured in restored wetlands, whereas drained wetlands produced an average of 3500 lbs/acre. The second study is part of the Saskatchewan component of Watershed Evaluation of Beneficial Management Practices (WEBS). This is a Canada-wide, Agriculture and Agri-Food Canada led research project evaluating the impact of beneficial management practices (BMPs). At the Pipestone Creek WEBS research site in Saskatchewan, wetland restoration is one of the BMPs being investigated for its impact on water quality and forage production. Wetland restoration treatments were applied in fall of 2010 in two locations, with a control site (drained) at each location.

0407

Crested Wheatgrass Diversification: Practical Experiences

Jerry Benson

BFI Native Seeds, Moses Lake, Washington, United States

Diversifying crested wheatgrass stands can be challenging. It is often important not only to know what to expect, but also what NOT to expect. Jerry Benson shares his 30 years of experience in diversifying crested wheatgrass stands. He has worked extensively in the Pacific Northwest and has been successful at increasing the diversity of many stands. His recent projects have been focused on diversifying crested wheatgrass for sage grouse management-- a topic that is likely to grow in importance! He will share some of his successes, and provide "real-world" tips for what to expect and what not to expect when embarking on a crested wheatgrass diversification project.

0408

Thirty-Year Persistence of 17 Plant Species in a Low Precipitation Zone

Mark Stannard, Clarence Kelley, Wayne Crowder
USDA Plant Materials, Pullman, WA, United States

Sixteen grasses and a legume were planted alone or cross-seeded with another species at the Washington State University Lind Dryland Experiment Station in 1977. The MAP of the site is 234 mm and 69% of the precipitation occurs between 1 October and 1 April. Nearly all of the species established and stands improved for the first three years. Few introduced species persisted beyond 14 years. *Poa secunda* cv. 'Sherman' big bluegrass was very aggressive and colonized nearly all the plots within 9 years. Two species, *Elymus wawawaiensis* cv. 'Secar' and *Pseudoroegneria spicata* cv. 'Whitmar', persisted with *Poa secunda* for 30 years. All three species originate within 300 km of the Lind Dryland Experiment Station and are major components of late seral range communities.

0409

Inter and Intra-State Cooperation: Nevada Partners for Conservation and Development

Lee Turner

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Nevada's Partners for Conservation and Development (NPCD), is a wide-view landscape and habitat restoration initiative formed in 2009 to leverage diverse interests including: government entities, NGOs, industry, citizens, and other like-minded organizations to mitigate and improve ecological health across Nevada's diverse landscape. The major goal of the NPCD is to provide cooperative mitigation of threats to land health through effective management and restoration actions on public and private lands in Nevada. This mission and goals will be accomplished based on a grassroots or ground-up model rather than the more traditional agency sponsored top-down approach. The NPCD is using the highly successful Utah PCD as a template. A large part of the Utah PCD's success has been via their regional teams' participation and the NPCD is forming regional teams by employing the successful model. The regional teams are composed of restoration focused staff and representatives of the NPCD, and other local conservation-minded organizations and stakeholders that reflect the ecologic, economic, and social demographics of that region. Each team is locally led and works cooperatively to plan and implement projects. The purpose of the regional teams is to serve as clearinghouses for coordinating and sharing participants' conservation concerns and priorities, discussing potential solutions and for cooperatively implementing conservation activities at the local level. A second contributor to the Utah PCD's success is participation at the agency director, state legislature and state agency levels. Significant funding is passed through the Utah PCD originating at the various agencies and state government.

0410

The Effect of Fairy Rings on Soil Aggregation and Rangeland Grasses

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A diversity of basidiomycete species form fairy rings in rangelands. These fairy rings occur as rings of darker green coloration than surrounding grass, and fruiting bodies (or basidiocarps) of the basidiomycete species are often present. Three fairy rings caused by a species of *Agaricus* were identified in a rangeland area of eastern Montana. Soil aggregation and plant community composition were quantified in three concentric zones, one within the area of the fruiting bodies (within-ring), a concentric ring 1m inside the fruiting body ring, and a concentric ring 1m outside the fruiting bodies. Western wheatgrass (*Pascopyrum smithii*) was the dominant grass in the within-ring zone while western wheat and needle and thread grass (*Stipa viridula*) were co-dominant inside and outside the ring. Little difference in vegetation inside and outside the ring indicates that the effects of these fairy rings on vegetation may be transient. Soil aggregation data indicate that the *Agaricus* species forming these rings may increase forage quality. This is supported by the observation that cattle preferentially grazed the within-ring area, a phenomenon documented in early studies of fairy ring biology.

0411

Field Establishment of Perennial Grass Seedlings in Cheatgrass Invaded Systems

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Successful establishment of seedlings in cheatgrass-invaded systems is a major management challenge in the Intermountain West. Using a combination of greenhouse and field experiments, we asked what traits increased seedling performance in field conditions, focusing on a population of big squirreltail (*Elymus multisetus*). We characterized seedling growth patterns of 40 individual plants, measuring phenology, root and shoot traits in a series of controlled sequential harvests from greenhouse-grown plants. Next, we planted 30 seedlings from each of the 40 parent plants into the field collection location in the Fall of 2009. Seeds were precision planted into either: 1) an uninvaded, primarily native, sagebrush steppe community, 2) a nearby invaded community, or 3) the invaded community with cheatgrass removed. Survival through the first growing season was high across all treatments, with 72.3%, 75.9%, and 74.5% of squirreltail seedlings surviving in the respective treatments. Plant sizes varied significantly between treatments, with seedlings in uninvaded areas producing about 30% more leaves and almost 50% more biomass than plants in the invaded area. Intermediate plant sizes were seen in the cheatgrass removal area. Seedlings from different parent plants differed in size and survival rates. Survival and field performance in uninvaded plots were correlated with multiple seedling growth traits measured in the greenhouse, however, the same traits did not predict performance in the invaded field plots. Cheatgrass creates a novel competitive environment for native seedlings, and our results suggest that novel mechanisms may be required for seedlings to establish in invaded areas.

0412

What Makes for Effective Collaboration?

Nat Frazer

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Wondolleck and Yaffee (2000) reminded us that "Collaboration is not an end in itself; it is one strategy for achieving more sound and sustainable resource management." Because ecosystem structure and function do not adhere to political or ownership boundaries, we have witnessed the emergence of collaborative efforts in natural resources management and conservation for several decades. From the perspective of 2011, I would add three pressing new reasons for the future proliferation of collaboration among natural resources managers. They are (1) the urgent need for both public and private managers to leverage increasingly scarce economic resources in a time of severe global recession, (2) the recent realization that climate change likely will be more rapid and more severe than we assumed just a few years ago, and (3) Interior Secretary Salazar's Order 3289 calling for the creation of collaborative Landscape Conservation Cooperatives (<http://www.fws.gov/science/SHC/pdf/SecOrder3289b.pdf>). Thus, the question before us is not whether we should or shouldn't increase our collaborative efforts. The fact is that we must. Our challenge is to determine what makes for effective collaborations. Drawing from my experience establishing a marine conservation organization involving over 30 governments in the Caribbean, published accounts of successful collaborations, and the experiences of professionals taking my Leadership for Natural Resources Professionals and Natural Resources Administration courses, I share some observations on characteristics of effective collaborations.

Literature Cited

J. M. Wondolleck and S. L. Yaffee. 2000. *Making Collaboration Work: Lessons from Innovation in Natural Resource Management*. Island Press. Washington, DC. 277pp.

0413

Optimizing Regional Collaborative Efforts to Achieve Long-Term Discipline-Specific Objectives

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Current funding programs focused on multi-disciplinary, multi-agency approaches to regional issues can provide opportunities to address discipline-specific advancements in scientific knowledge. Projects funded through the Agricultural Research Service, Joint Fire Science Program, and the Natural Resources Conservation Service have resulted in an extensive dataset for predicting rangeland hillslope runoff and erosion responses to management treatments and natural disturbances. Hydrologic experiments funded through these projects have investigated the hydrologic impacts of fire, soil water repellency, plant community transitions, and other disturbances across local and regional spatial scales. The distribution of the study sites associated with these projects span the western United States. Research programs at the USDA-ARS Northwest Watershed Research Center (NWRC) in Boise, Idaho, demonstrate how involvement in such regional, multi-disciplinary, multi-agency efforts can be used to develop broadly applicable rangeland management tools. Two decades of NWRC research focused on vegetation management, wildfire, and woodland encroachment effects on runoff and erosion from rangelands have been largely funded by collaborative efforts and results are now being pooled with similar efforts elsewhere to parameterize and advance rangeland hydrologic modeling. These advancements have broad application across western rangelands and provide useful predictive tools for rangeland scientists and managers alike. We suggest that such approaches provide not only project-specific multi-disciplinary knowledge advancement, but can be used, over a period of time, to advance discipline-specific knowledge.

0414

Landowner, NGO and Local Government Cooperation: The Owyhee Initiative

Chad Gibson

Private Consultant, Owyhee County, Idaho, United States

The collaborative effort known as The Owyhee Initiative includes representation of local landowner interests through the Owyhee Borderlands Trust, Soil and Water Conservation Districts, Owyhee County Farm Bureau and Owyhee Cattlemen's Association. Conservation interests are represented by the Nature Conservancy, Wilderness Society, Idaho Rivers United, Sierra Club and Idaho Conservation League. Related recreational and wildlife interests include the Back Country Horsemen, South Idaho Dirt Racing Association, Wild Sheep Foundation and, Idaho Outfitters and Guides Association. The success of such a diverse group depends largely on leadership, agreement on the common interests to be addressed and those issues to be avoided and perhaps most importantly a commitment to approach the process with an open mind and true interest in understanding all sides of each issue. Leadership is needed to keep the discussions focused and assure opportunity for all participants to be adequately heard. Limiting the issues to those with interacting effects that provide some level of benefit to multiple interests avoids the gridlock issues that prevent agreement. A commitment to seek and agree on common ground issues is essential in keeping everyone at the table long enough to work through the tough questions. Many elements of the agreement were addressed legislatively; however, the Agreement goes well beyond the terms of the legislation. Consequently, the Owyhee Initiative group was incorporated and now serves to oversee and assure that legislation implementation remains true to the Agreement and those elements of the Agreement not fully addressed by the legislation are fully applied.

0415

The Great Basin Native Plant Selection and Increase Project - Linking Research, Management and the Native Seed Industry

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Initiated in 2001 through the Federal Interagency Native Plant Materials Development Program by the USDI Bureau of Land Management and the USDA Forest Service, objectives of the Great Basin Native Plant Selection and Increase Project are to 1) provide regionally adapted, genetically appropriate native plant materials, primarily herbs, for use in the Great Basin, 2) develop cultural practices and increase the private sector capacity for producing seeds of these materials, and 3) devise strategies and adapt equipment for improving the establishment of diverse native communities. To meet challenges posed by these objectives, the initial collaboration has expanded to include more than 20 researchers in disciplines ranging from genetics to agronomy, entomology, seed technology, climate change, restoration ecology, and equipment development. State seed regulatory agencies have aided by maintaining and distributing stock seed and addressing issues relative to the evolving prevaryety germplasm program. Lack of stability in the native seed market and high initial cost of new materials have created major obstacles to the success of this program. Efforts to solve these problems include expediting science delivery to the seed industry and land managers to effect acceptance and use of new materials, establishment of provisional or species-specific seed zones that provide growers with a better indication of potential market needs, increased seed storage by buyers and growers to reduce spikes in purchasing in major fire years, purchasing through contracts rather than the open market for materials of limited geographic range, and increasing the market across public and private sector users.

0416

Communicating Effectively with Livestock Producers

Fee Busby

Utah State University, Logan, Utah, United States

Communications with livestock producers range from providing technical assistance to an individual rancher, to writing a wide array of documents associated with contracts and grazing permits, to letters which have to be sent by registered mail informing an individual of some action that must be taken. Communication also requires listening to the response one gets from any of these communications. In the context of this symposium, "effective" communication means that communication from the rangeland management specialist to the livestock producer results in some action that benefits the land, the rancher and the public. The person wanting to deliver a message must not only understand the content of the communication but the likely response of the individual receiving the message. Assuming that most rangeland management specialists understand the content of the message they need to deliver, no matter what the purpose or method, it seems that a common failure in the communication process is that the person(s) receiving a message are not capable of receiving it in a manner that can be considered "effective". That failure may be due to a person not having sufficient knowledge of the subject but more often will be due to their not being prepared to receive the message. A second failure is that the person initiating the communication does not understand why the message fell on deaf ears. Effective communication requires a plan that addresses not only the content of the method but preparation of the person to receive the message.

0417

Payments for the Provision of Ecological Goods and Services

Peter Boxall

University of Alberta, Alberta, Canada

While many producers look to emergent commodity markets as opportunities to be paid for providing EGS, the requirements for these markets to function properly are austere. Policy makers are looking to market based policy instruments to increase EGS from private lands. These include: conservation auctions, offsets and mitigation banks, and tradable permits and development rights. All of these schemes utilize a "payment for ecosystem services approach" with the funding coming from taxpayers or environmental organizations. We have been exploring the use of auctions in Canada to provide incentives for adopting BMPs such as run-off holding ponds, forage conversion and wetland restoration. While much of this work has involved experimental economic procedures, pilot auctions with producers in various watershed communities have been conducted or are underway. These represent opportunities for producers to be paid for EGS provision and require different types of market structures. One of the useful features of these instruments is the provision of "price" or cost of provision information to policy makers. This information is needed to develop sounder policy options, and to understand more fully the efficacy of the hypothesized emerging markets.

0418

The US Rangeland Base: A Comprehensive Geographic Analysis of the Extent of Coterminous US Rangelands

Matt Reeves

USDA, Forest Service, Rocky Mountain Research Station, Missoula, MT, United States

Rangeland extent is an important factor for evaluating critical indicators of rangeland health. Rangeland areal extent was determined for the coterminous USA in a geospatial framework by evaluating spatially explicit data describing historic and current vegetative composition, average height and average cover representing the landscape circa 2001 through the viewpoint of the Natural Resources Conservation Service and United States Forest Service. Four types of rangelands were differentiated using the NRCS definition including rangelands, afforested rangelands, transitory rangelands and rangeland vegetation with a small patch size. Limitations in the USFS definition only permitted characterization of two rangeland types including "rangeland" and rangeland vegetation with a small patch size. These classes were similar to those from the NRCS definition but differed in tree canopy cover threshold requirements. Estimated rangeland area resulting from the NRI- and FIA-LANDFIRE models resulted in 220 and 188 Mha respectively. In addition, the NRI-LANDFIRE model identified 19 Mha of afforested rangelands due principally to encroachment and densification by *Quercus*, *Prosopis* and *Pinus* spp. The biggest discrepancies between acreage estimates derived NRI- and FIA-LANDFIRE models occur in oak, pinyon juniper and mesquite woodlands. The differences in area estimates between the NRI and FIA perspectives demonstrate the need for development of a unified, objective rangeland definition which can be applied consistently and spatially anywhere in the US.

0419

Highlights of the 2010 RPA Rangeland Assessment

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The Renewable Resources Planning Act (1974) requires the US Forest Service to make decadal assessments of critical resources including rangelands. The last assessment was conducted in 2000 and therefore, a new assessment has been conducted during 2010. The 2010 assessment evaluates the status and trends of selected topics pertaining to rangelands such as: The US rangeland base (extent), rangeland productivity trends, rangeland health, ecosystem services, energy development and livestock trends. Here we provide brief highlights of the 2010 RPS assessment and indicate the future direction of research to fulfill the requirements of the legislation.

0420

Agency Accomplishments - Making A Difference On-the-Ground

Linda Coates-Markle

Bureau of Land Management, Washington, DC, United States

Many government agencies are not provided adequate opportunities to market their successes as workloads and priorities often restrict time and budgets. The intent of this session is to promote an opportunity to demonstrate the often unique and well-fought efforts to accomplish laudable and partner-based goals. The agenda will include presentations reflecting the successes of agency partnerships with researchers and ranchers, NGOs and others. The focus will be on on-the-ground accomplishments within an ecoregional perspective but there are a variety of avenues to create these opportunities and many will be explored during this session. Within these talks, presenters will address the primary problem (concern), discuss the collaborative process that brought the partners together and highlight accomplishments to date. Inevitably these efforts will foster improved communication with the goal of developing even more opportunities for successful partnerships.

0421

Climatic Control of Sagebrush Survival in Semi-Arid Ecosystems of Nevada

Erin Hourihan, Barry Perryman

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Sagebrush (*Artemisia* spp.) is widespread in the western US and especially well adapted to life in the arid Great Basin. Recently many healthy sagebrush ecosystems have experienced increasing levels of disturbance. The invasion of non-native annual grasses has narrowed the fire return interval, putting native woody perennials at a competitive disadvantage. Shrub recruitment in arid regions commonly occurs in pulses and is controlled by specific climatic conditions; previous research suggests that sagebrush is no exception. This study investigated the relationship between climatic variables and shrub cohort establishment and survival of four species or subspecies of sagebrush Wyoming sagebrush (*Artemisia tridentata* subsp *wyomingensis*), black sagebrush (*Artemisia nova*), low sagebrush (*Artemisia arbuscula* subsp *arbuscula*), and Lahonton sagebrush (*Artemisia arbuscula* subsp *longicaulis*) in Nevada. The primary goal of this research is to identify the climatic triggers that control recruitment of these species. During 2009 and 2010, 80 stem sections were collected from nine stands of each of the 4 species or subspecies. Study sites were located throughout the state. The sites were characterized by the absence of fire and the presence of multiple age classes. Annual growth-ring analysis was used to identify the year of establishment. Frequency distributions in the preliminary results indicate pulses of establishment for these species and subspecies of sagebrush do exist.

0423

Clover Seeding for Sage-Grouse Habitat and Forage Production on Mountain Meadows

Matt Barnes, Joe Brummer, Lars Santana, John Scott, Mark Volt
USDA-NRCS, Colorado, United States

Greater and Gunnison sage-grouse forage in wet meadows adjacent to sagebrush rangelands. Both sage-grouse species are thought to require a higher proportion of forbs and associated insects in their diets than is usually available in either grass-dominated wet meadows or sagebrush rangelands, especially during brood-rearing. This is thought to be a limiting phase in the life-cycle of these species of concern. Most of the wet meadow - sagebrush edge habitat in the Southern Rocky Mountains occurs on private grazing land. Legumes have higher forage quality than grasses in mountain meadows. Planting legumes in grass-dominated meadows can increase their overall productivity, as well as the productivity of some grass species. Two legumes that establish and produce well in mountain meadows are mammoth red (*Trifolium pratense* var. *sativum*) and alsike clover (*T. hybridum*). To enhance forage quality, diversity, and production, increase the amount of forbs and associated insects available to sage-grouse, and improve relationships between private landowners and government agencies, we collaborated with landowners and other agencies to seed clover on most of the irrigated mountain meadow edge adjacent to sagebrush rangeland in both the Gunnison Basin and Middle Park. The two collaborative projects involved 116 private landowners, represented by the Gunnison and Middle Park Conservation Districts and the Gunnison County Stockgrowers Association, along with the USDA Natural Resources Conservation Service, Colorado State University, Colorado Division of Wildlife and its Habitat Partnership Program, USDI Fish and Wildlife Service Partners for Wildlife Program, USDI Bureau of Land Management, and Gunnison County.

0424

Database for Inventory, Monitoring and Assessment (DIMA)

Ericha Courtright, Barry Lavine, Jason Karl, Scott Schrader, Brandon Bestelmeyer, Laura Burkett, Jeff Herrick

USDA-ARS Jornada Experimental Range, Las Cruces, United States

Land managers increasingly need to collect, store, and analyze monitoring and assessment datasets that include multiple methods and occur over multiple years. The Database for Inventory, Monitoring and Assessment (DIMA) is a highly customizable software tool for data entry and interpretation. DIMA can be utilized on a tablet PC to collect data electronically in the field, thereby freeing up countless hours of data entry. Stored data are easily exported to other databases and spreadsheets while data previously entered in Excel can be quickly imported into the database via templates. Calculated data summaries, including graphs, can be automatically generated from entered data. These data summaries can be all-inclusive over many years or broken down by year based on selected indicators (i.e., plant growth form, special user-defined identifiers, etc). A demonstration will be provided highlighting the advantages of using DIMA. Following the symposium, participants may demo DIMA on a tablet PC at a booth in the exhibit hall.

0425

Tools for Analysis of Very-High Resolution Images

Jason Karl¹, Terrance Booth², Scott Schrader¹, Samuel Cox³

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Very-high resolution (VHR) aerial imagery has many potential applications for rangeland monitoring, assessment, and inventory, and advances in technology and availability have moved VHR-image products from research to application in rangeland management. To be useful for creating indicators of rangeland status and trend, however, VHR imagery must be converted to measures and estimates of ecosystem parameters through automated or human-assisted analysis techniques. In this presentation, we review current options for deriving rangeland ecosystem indicators from VHR imagery and discuss several available tools for analyzing imagery including SamplePoint, ImageMeasurement, and ImageInterpreter. Demonstrations will be provided for each tool as well as discussion of advantages and limitations. Following the symposium, participants may try each software tool at a booth in the exhibit hall.

0426

Practical Sample Design and Selection Tools for Rangeland Monitoring and Assessment

Jason Karl

USDA Agricultural Research Service, Jornada Experimental Range, Las Cruces, NM, United States

Successful monitoring and assessment depends on clearly stating monitoring objectives and selecting an appropriate combination of indicators, measurement methods and sample design. However, sample design - particularly the selection of locations for field sampling - can be one of the most intimidating parts of designing a monitoring or assessment program. There are, though, many tools and information sources available to make the process easier and increase the likelihood that data will be useful for its intended purpose. In this presentation, we review some basic concepts of statistically-based sample design and selection and provide a practical demonstration of several helpful web-based and GIS tools. These tools will cover a range of sample design tasks including sample size calculation, stratification, sample location selection, and data analysis. Following the symposium, participants may try each of the demonstrated tools and ask questions at our booth in the exhibit hall.

0427

Standardized BLM and NRCS Inventory and Monitoring Protocols

Carol Spurrier¹, Pat Shaver²

¹*Bureau of Land Management, Washington, DC, United States*, ²*National Resources Conservation Service, Portland, OR, United States*

Standardization of monitoring methods allows land managers to combine data across management units and jurisdictions. Standardization also allows data to be compared among various areas, including those with different management systems. The BLM and NRCS have adopted several standardized monitoring methods including line point intercept, height, and a measurement of large inter-canopy gaps. Together these methods can be used to generate indicators of plant community composition, wildlife habitat structure, and wind and water erosion. All three methods are included in the NRCS National Resource Inventory of all non-federal lands and have been adopted as core methods in the BLM Assessment, Inventory and Monitoring Strategy. Both agencies have also adopted several other standardized methods including a field test kit for measuring soil aggregate stability. Following the symposium, participants may demo the methods using a constructed plant community at a booth in the Exhibit Hall

0428

PLANTS and VegSpec - Plant Characteristics, Taxonomy, and Restoration Tools

David Pyke

US Geological Survey, Forest & Rangeland Ecosystem Science Center, Corvallis, OR, United States

The day and age of interacting databases for plant management has arrived. PLANTS is a regularly updated database for plants information. It incorporates rapidly changing plant nomenclature while capturing ever increasing synonyms for plants. In addition, PLANTS includes information on plant characteristics such as nativity, life and growth forms, and wetland status. A subset of PLANTS has detailed information on over 90 plant growth and production characteristics. These plants are linked directly to VegSpec, a plant revegetation expert and decision support system. VegSpec links these plant characteristics to spatially explicit climate and soil databases to estimate which plants might grow and survive at locations across the USA. Users identify a location and VegSpec clips appropriate climate information from the PRISM database and appropriate soil components from an NRCS soil database. The user is then able to select potential land uses. With this information, VegSpec searches the subset of PLANTS for species with characteristics that will potentially allow establishment and growth at the site. From a potential plant list, users select specific plants and then enter a planting design module that aids in determining the type and amount of plants to seed or plant. Printed records of choices can be kept and filed for further use in revegetation planning.

0429

Conservation of *Draba* in the Intermountain West: The importance of hybridization, ploidy, breeding system, endemism and biogeography.

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¹Brigham Young University, Provo, UT, United States, ²Duke University, Durham, NC, United States

With a growing number of plant species in danger of extinction due to human induced threats, species-by-species approaches to management are becoming unrealistic. In order to protect these species, we need to determine whether there are patterns associated with rarity and endemism that would facilitate the development of management strategies applicable to a wide range of rare taxa. For this study, we surveyed species in the genus *Draba* from the Intermountain West, the region with the highest concentration of endemics. We collected data on geographic distribution, degree of endemism, chromosome number, ploidy level, breeding system and reproductive success for most of the rare, endemic *Draba* species occurring in Utah, Idaho, and Nevada. The study revealed some interesting evolutionary and biogeographic patterns. For example, endemic *Draba* species from the Wasatch and Rocky Mountain regions were primarily diploid, outcrossing, paleoendemic species with relatively low fecundity. Conversely, endemic *Draba* species from the Great Basin region of western Utah and Nevada were primarily polyploid, autogamous, neoendemics with relatively high fecundity. These patterns appear to reflect both the type of speciation that occurred and the geologic/biogeographic history of the region. Many *Draba* species, as currently circumscribed, include more than one ploidy level, due to a variety of factors such as: autopolyploidy, allopolyploidy, and convergent evolution. Therefore, these *Draba* species should not be treated as single panmictic taxa for purposes of conservation.

0430

A Rangeland Hydrology and Erosion Model

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Soil loss rates on rangelands are considered one of the few quantitative indicators for assessing rangeland health and conservation practice effectiveness. An erosion model to predict soil loss specific for rangeland applications is needed because existing erosion models were developed from croplands where the hydrologic and erosion processes are different. The Rangeland Hydrology and Erosion Model (RHEM) was designed to fill that need. RHEM is an event-based derivation of the WEPP model made by removing relationships developed specifically for croplands and incorporating new equations derived from rangeland data. RHEM represents erosion processes under disturbed and undisturbed rangeland conditions, it adopts a new splash erosion and thin sheet-flow transport equation developed from rangeland data, and it links the model hydrologic and erosion parameters with rangeland plant communities by providing a new system of parameter estimation equations based on 204 plots in 49 rangeland sites distributed across 15 western U.S. states. RHEM estimates runoff, erosion, and sediment delivery rates and volumes at the spatial scale of the hillslope and the temporal scale of a single rainfall event. Experiments were conducted to generate independent data for model evaluation and the Coefficients of Determination (r^2) of runoff and erosion predictions were 0.87 and 0.50 respectively, which indicated the ability of RHEM to provide reasonable runoff and soil loss prediction capabilities for rangeland management and research needs. A web-based version of this model now allows managers and students, as well as scientists, to easily predict soil erosion rates across a wide variety of conditions.

0431

Pyric Herbivory in Central Montana Sagebrush Communities: Contrasting Domestic and Native Herbivores

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The effect of fire on an ecosystem has long been studied, but only recently has the interaction between grazing and fire been addressed. Pyric Herbivory - the increased grazing response of ungulates to fire events - has the potential for patch burning to be used as an effective management tool in promoting increased heterogeneity in shrub (*Artemisia tridentata* spp. *wyomingensis* (Beetle & A. Young) S.L. Welsh) - bunchgrass plant communities. The purpose of this study was to determine the combined effects on vegetation response to grazing exclusion by species with growing-season fires in the sagebrush steppe/Northern Great Plains ecosystem in central Montana. The study sites are located on the Charles M. Russell, National Wildlife Refuge located 60 miles south of Malta, MT. Three long term grazing exclosures in upland sagebrush dominated communities were used which successively exclude domestic cattle, wild ungulates, rabbits, and grasshoppers for two summers. Half of each of the long term grazing exclosures was burned, simulating both burned and unburned treatments in each of the grazing exclosures. Burning resulted in regrowth of primarily grass species one month after burning in all grazing treatments. Both fire and grazing treatments resulted in differences in community composition and structure in this shrub-bunchgrass plant community. Further research will indicate the important of the interaction of these disturbances and how they may shape the long term trajectories in ecosystem dynamics.

0432

Wolf Reintroduction: A Montana Perspective

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Wolf reintroduction in the state of Montana has shown to have consequences far surpassing initial estimates. Speaking from the viewpoint of a 6th generation native Montanan as well as a board member for Montana Sportsmen for Fish and Wildlife, I will discuss effects of wolves on wildlife populations, hunter harvest, hunter behavior, ranchers and livestock, as well as wildlife related businesses. Data for this presentation will encompass published research, MT FWP harvest statistics, family history, and surveys from the Montana Sportsmen for Fish and Wildlife membership, thereby providing a picture of the situation that is complete from all viewpoints of the everyday Montanan.

0433

The Rise and Fall of Western USA's Great Elk Herds

David Allen

Rocky Mountain Elk Foundation, Montana, United States

The

0434

Automated Generation of Very-High Resolution Orthomosaics and 3D Models in support of Fine Scale National Resource Applications

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The BLM, in partnership with ARS and other agencies, has been evaluating the application of photogrammetric processing techniques to very-large scale aerial (VLSA) imagery to support collection of quantitative datasets for a variety of natural resource applications. Pilot projects along the Powder River, Moccasin Mountain Dinosaur Track Site, Legend Rock Petroglyph Site and others, have led to the development of a standard protocol to support the automated generation of orthomosaics and 3D terrain models from very high resolution imagery captured from a variety of platforms. Though technical hurdles remain, BLM has demonstrated that if proper stereo imagery collection parameters are followed, we can now rapidly produce high accuracy orthophotos and digital terrain models without ground control and minimal manual image post-processing. The primary tools needed to support this work in the field are the acquisition platform (i.e., light aircraft, Unmanned Aerial System, blimp, tripod), digital camera, a GPS unit, and flight planning and control software. In theory, the absolute accuracy of the resulting data products can match the accuracy of the GPS used in the imagery capture. In practice, the accuracy is driven by the quality of the images and the operational conditions at the time the data are collected. The goal of this work is to establish a low-cost, easy access, and rapid processing environment to deploy digital stereo imagery and derived products to resource managers and specialist across the bureau.

0435

Sentinel Plants: Diagnostic Guides for Adaptive Management

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Sentinel plant species are those that are first to vanish with change to the evolutionary concert of ecological processes playing within a landscape. First to vanish species are highly palatable to herbivores and often excellent pollinator species that produce nutritious seeds or fruits. Most sentinel species are diagnostic for the cumulative effects of two or more ecological processes. Restoration of sentinel plant species is accomplished by re-establishing the evolutionary combination of ecological processes that permitted viable populations. Sentinels are usually (but not always) not grasses. Most sentinels are forbs, shrubs, and trees. Grasses have low growing points (relative to forbs, shrubs, and trees) and are unusually resistant to disturbances such as fire and herbivory. Vegetation classifications (such as Ecological Site Descriptions) describe primarily dominant plant species. Less common process sensitive sentinel species are often not emphasized. Dominant existing plant species are a reflection of past ecological processes and may not be the species that are most easily lost. Classification designations usually do not change with the disappearance of management sensitive uncommon species. Thus classifications are useful primarily for coarse descriptions of landscapes and maps but lack the substantial utility of sentinels for monitoring or management of ecological processes.

0436

Using Cattle Supplementation to Enhance Range Wetland Condition

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In the western prairie pothole region of Montana, the high concentration of wetlands places constraints on traditional wetland conservation practices; there are simply too many wetlands to fence. Strategic placement of flavored cattle supplements can facilitate natural recovery and restoration of wetland plant communities and limit repeated damage to wetland soils that have been subjected to intensive grazing. Minimizing the time cattle spend near wetland edges can reduce soil pugging and allow for vegetation recovery. Wetlands where supplements were used did not suffer any degradation, and vegetation cover increased over the season, in contrast to plant cover decrease seen in wetlands located in pastures where no supplements were used. When supplement is placed 500 meters or more away from wetland areas, cattle appear to spend more time around supplement barrels. Placing supplement barrels at high points where there is some wind protection and visual advantage keeps cattle near supplement barrels during resting periods and during the night. As an additional benefit, strategic barrel placement located away from wetlands can decrease the amount of fecal material left in or near wetlands, potentially improving water quality. Full recovery may require supplement use in pastures for several years in combination with lower stocking rates. These practices, in combination with annual freeze thaw cycles and wetting and drying, will assist in soil structure recovery, recovery of wetland plant communities, potential increase in water quality, and waterfowl nesting cover. Flavored supplements show high potential to be used as a wetland conservation and improvement management tool.

0437

Nature's Engineers - Wildlife as Agents of Ecological Change

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Until recently, with the exception of domestic livestock herbivory, most actions driving plant succession as described within Ecological Site Description State and Transition models were abiotic. The more well understood movement from one community phase change to another and threshold drivers between or among states, including fire, avalanche, floods, drought, rest, timber harvest, and mechanical vegetative treatment are the elements commonly seen and understood to move vegetative states and transitions. With recent research findings that suggest vegetative community changes are heavily influence by trophic cascades set in motion by apex predators (wolves, lions, and bears), the impact of other animal actions on vegetative trajectories are being examined. In this symposium we will examine roles of such environmental engineers (animal architects) as insects, salmon, beaver, prairie dogs, songbirds, and apex predators in the determination of community phases and pushing communities across thresholds to different vegetative states.

0438

Developing Native Plant Materials and Applying Management Practices to Repair Disturbed Landscapes

Jack Staub

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Plant improvement has historically played an essential role in the repair of disturbed ecosystems. However, the collection, evaluation, and improvement of native plants, and the concomitant development of management strategies is often a long and arduous task. Moreover, although novel native plants have been developed, their successful use in the restoration of disturbed landscapes in suboptimal growing environments is often not fully realized. Concepts, methods, and issues underlying native plant improvement and development of unique management practices for the repair of such landscapes is not common knowledge among SRM members. This symposium seeks to provide society members with information regarding the development of native plant materials and management practices for repair of disturbed landscapes.

0439

The Ecology of Seedling Establishment on Rangeland

Jeremy James

USDA-ARS, Burns, OR, United States

Seeding disturbed or degraded rangeland is a central tool managers use to stabilize soils, inhibit the spread of invasive plants, and facilitate recovery of desirable vegetation. Much research has been directed towards seeding technology and plant material development yet rates of successful seeding on arid rangeland are very low and typically confined to years with above average crop year or growing season precipitation. Despite the important role rangeland reseeding plays in management, as a field we still have a very limited understanding of the ecological processes driving patterns of seedling establishment. As a consequence, we have a poor understanding of the mechanisms driving failure and a limited ability to make substantial improvements in seeding technology. This symposium brings together research projects that span key topics that link the ecology of seedling establishment to how we might make practical improvements in our on the ground restoration efforts.

0440

Conifer and Abiotic Factors Influence on Big Sagebrush Cover

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Expansion of conifers into sagebrush is a concern since it reduces sagebrush cover for wildlife. The objective of this study was to model the relationship between Douglas-fir (*Pseudotsuga menziesii*), Rocky Mountain juniper (*Juniperus scopulorum*), elevation, slope, aspect, and soils and Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*) and mountain big sagebrush (*Artemisia tridentata* spp. *vaseyana*). Two hundred forty 30x30 m plots were established at three locations in southwest Montana in 2009 to establish this relationship. The best-fit model using AIC criteria found ($a_i = -0.401$, $r^2 = 0.61$) a negative relationship between conifer cover and sagebrush cover. No environmental factors significantly influenced sagebrush cover. Douglas-fir trees were found to have four-times the canopy area of similar aged Rocky Mountain juniper trees. Conifer removal to increase sagebrush cover is not recommended, since the increase in sagebrush cover is small. If conifer control is deemed necessary, Douglas-fir should be removed before Rocky Mountain juniper.

0441

Effects of a Single Grazing Event by Cattle on Terrestrial Invertebrates Falling Into Streams and Trout Populations: Results of a Field Experiment

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Recent research has shown that terrestrial invertebrates are important prey resources for trout, often providing about 50% of their annual energy and having strong effects on growth and abundance. However, the importance of this prey resource in rangeland streams has received little attention, and there has been no experimental test of whether riparian grazing by livestock reduces this important prey resource. During summer 2008, we conducted a field experiment to test whether cattle grazing alone, or grazing and manual removal of woody riparian vegetation, affect trout populations by reducing terrestrial invertebrate prey in central Wyoming streams. We tested three, short duration (2 - 11 d), grazing treatments: 1) moderate intensity grazing (10-15 cm stubble height), 2) high intensity grazing (5-7.5 cm stubble height), 3) high intensity grazing plus removal of two-thirds of streamside woody vegetation, and 4) a control with no livestock grazing. Overall, short durations of moderate and high intensity grazing had little effect on terrestrial invertebrates entering streams, but grazing plus removal of streamside woody vegetation caused significant reductions in terrestrial invertebrate inputs to streams. In contrast, all experimental treatments reduced the biomass of terrestrial invertebrates in late-summer trout diets. However, these effects did not translate to reductions in trout populations. These results indicate that terrestrial invertebrates falling into streams may be relatively resistant to short, but intensive, bouts of grazing, and that grazing systems that incorporate short grazing bouts and maintain streamside woody vegetation, may also support the terrestrial prey resources necessary to sustain robust trout populations.

0442

Status and Management of Amphibians on Montana Rangelands

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I developed a statewide inventory and monitoring scheme for lentic breeding amphibians and aquatic reptiles in Montana. Field crews surveyed 6,741 potential lentic sites on public lands between 2000 and 2008 within 429 randomly selected 12-digit hydrologic-unit-code watersheds. Naïve watershed and site breeding (eggs, larvae, or breeding adults) rates of 10 amphibian species and naïve occupancy rates of 4 aquatic reptile species were the primary response variables of interest. However, I also used classification trees to examine patterns in naïve rates resulting from different groupings of major habitat features that resource managers may be able to effect with management actions. The presence of emergent vegetation was positively associated with the proportion of sites where breeding or occupancy was detected for all but one of the amphibian and reptile species examined and appeared to mitigate the presence of fish to some extent. Resource managers could enhance habitats for wetland herpetofauna within their administrative boundaries by: 1) creating new lentic sites on the landscape either directly or through the reintroduction and protection of beaver, 2) creating emergent vegetation at portions of existing sites that currently lack it via rotational fencing to temporarily exclude grazing, and 3) eliminating fish populations. Resource managers can access information on observations and survey locations, including digital photographs of sites surveyed at <http://nhp.nris.state.mt.us/Tracker>

0443

Landscape Associations, Water Chemistry, Human Use, and Characteristics of Great Basin Spring-Fed Aquatic and Riparian Communities

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Great Basin springs are typically small and isolated from other aquatic systems, and many are occupied by crenobiontic vertebrates and macroinvertebrates. They are a focus of groundwater studies, and over the past 30 years there has been increasing recognition of their importance as biodiversity hotspots and as habitat for rare species. Many rare species have been subject of taxonomic, physiological, and biogeographic studies, but ecological knowledge remains in its infancy. Consequently, there is weak understanding of relationships between biota, physicochemistry, and ecological interactions, and the consequences of incrementally increasing stresses of human activity on their ecological integrity. A conceptual model of spring ecology that integrates groundwater hydrology, biology, ecological processes, and landscape associations is needed to: 1) identify best sites for ecological research, 2) monitor the effects of groundwater use, 3) prioritize restoration sites, and 4) identify field laboratories where ecological effects examining the effects of climate variability aquatic systems can be examined. Quantitative and qualitative studies at more than 4,000 Great Basin and Mojave Desert springs over the past two decades provides insight into biotic/abiotic relationships. More than 85 percent are badly disturbed by humans where multiple use strategies are fundamental to land use, and many others dry or are scoured by flood. Although the rarity of undisturbed springs complicates derivation of integrated conceptual models of spring ecology, recent work shows that human and natural stressors may predictably affect functional characteristics of riparian and benthic macroinvertebrate communities. A preliminary conceptual model integrating hydrology, landscape associations, land use, and spring biology is presented.

0444

USDA NRCS Conservation Program Financial and Technical Assistance to Support Producers in Conservation, Assessment, and Business Planning

Mark Parson, Dennis Thompson

USDA Natural Resources Conservation Service, Washington, DC, United States

Mark Parson will present information about current opportunities to obtain financial and technical assistance through programs administered by the Natural Resources Conservation Service (NRCS). The agency provides assistance to producers, farmers, ranchers, forest owners and Tribes to help implement conservation practices. Payments for implementing practises includes those that offset costs incurred, and those that support acquiring technical knowledge, training, record-keeping, and monitoring, and costs associated with income foregone. Dennis Thompson will provide insight to the kinds of conservation practices available to address range and animal-related needs as well as technical services available from NRCS.

0445

Redefining Large Carnivore-Livestock Management: A Working Model for Reducing Livestock Conflicts on Public and Private Land in the Mountain West

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Mountain Livestock Cooperative, Bozeman, Montana, United States

To reduce a broad suite of economic impacts resulting from carnivore-livestock conflicts, we recommend a paradigm shift in livestock management in areas where they are grazed in the presence of large carnivores on public and private land. Traditional livestock grazing practices developed during a time when large carnivores were largely absent from rangelands in the mountain west now contribute to and exacerbate the repeat nature of carnivore-livestock conflicts. Using 15 years of wolf depredation data from the Rocky Mountains of Canada and the U.S., we show that large carnivore depredations on livestock (cattle) focus on the most vulnerable age classes (calves and yearlings) and that wide dispersion of domestic animals that are behaviorally prone to anxiety and flight, and predictably located across all seasons of the year create 'repeatable environments' that facilitate learning and association of livestock as prey by large carnivores. We provide examples and a year-long 'working model' of effective practices applied during winter through summer for minimizing risk to cattle, and recommend modified livestock grazing as a tool for reducing their availability and vulnerability to large carnivores at a scale that is biologically relevant. We conclude by recommending existing federal policy mechanisms to provide federal and matching funds to livestock producers, on a willing basis, for experimenting with livestock grazing management as a tool for improving livestock production, range health and stewardship toward preventing conflicts with large carnivores in the mountain West.

0446

"Burn early, burn often:" Contrasting Aboriginal Versus Modern North American Fire Management Regimes.

Cliff White

Parks Canada, Banff, Alberta, Canada

Similar to the world's other peoples, Native American's long-term use of fire was sophisticated and influenced by the plant and animal resources required for subsistence, warfare, and other cultural complexities. Current land management objectives often require that the interaction of plants and animals with long-term fire regimes be understood, and in many cases restored. Traditional knowledge studies suggests that historic anthropogenic fire management differs from modern practices in many ways. Importantly, past fire use varied spatially between core occupation areas and buffer zones and between different human groups. During the annual cycles of vegetation wetting and drying, human burning in core occupation areas was relatively frequent, and generally occurred early in drying periods to pre-empt later burning by lightning or other unplanned sources (e.g., warfare). This early-season burning could occur in the fall, winter, or spring depending on the pattern of precipitation and winter temperatures. These low or moderate severity burns typically resulted in relatively stable and predictable ecosystem responses, and high landscape diversity. In contrast, contemporary fire management favors mixes of fire suppression and very limited prescribed burning that tends to "put fires off" until a major drought period (usually mid or late summer) after a long fire interval (with high biomass accumulation). The resulting large-area burns, increasingly contained by the indirect control technique of using high intensity fires caused by aerial ignition, can radically alter ecosystem conditions. Restoring fire regimes requires an understanding of long-term anthropogenic patterns.

0447

Crossings, Corridors and Trophic Cascades: Wolves and Woody Vegetation in Banff National Park

Cliff White

Parks Canada, Banff, Alberta, Canada

In the early 1900s, removal of native peoples, predator control, and re-introduction of elk resulted in high ungulate densities in the BNP. High ungulate herbivory resulted in the nearly no regeneration of aspen to heights above 2m by the late 1930's, and in concert with ongoing fire suppression, led to numerous other changes in long-term patterns of trees, shrubs, and wildlife habitat. The issue, a focus of both research and management for several decades, became critical when aspen regeneration continued to fail after prescribed burning began in the 1980s. Wolves recolonized the Bow Valley in 1985, assisted by construction of wildlife fences and crossing structures across the Trans Canada Highway, and establishment of wildlife corridors and habitat patches around areas of human development. From 1985 to 2005 elk densities through most the valley declined by 90%, largely due to wolf predation, but also other actions such as culling human-habituated elk near the Town of Banff with the participation of First Nations, and increased grizzly bear use of highway crossing structures. The cover and height of almost all woody plant species increased in a spatial pattern inverse to elk densities. Recent prescribed burns accelerate regeneration of native shrubs, possibly by creating dense deadfall patches avoided by predation-averse ungulates. Although populations of several large ungulates declined during the initial wolf recolonization period (when both elk and wolf densities were high), trophic cascade and spatially-variable fire effects may maintain important wildlife habitat for numerous species including moose, deer, beaver, and several bird species.

0448

Locating Monitoring Sites in a Mixed Ownership Landscape

Edward Petersen

USDA - NRCS, Ontario, Oregon, United States

Malheur County, Oregon, has a diverse landscape that is a mix of private and public land. Some larger range pastures have a mix of public and privately owned lands within a single grazing unit. With the implementation of the Conservation Stewardship Program by NRCS during fiscal year 2010, one of the enhancements is to monitor grazing use and range condition on private lands. Many ranchers in Malheur County chose this enhancement. To monitor the grazing use and rangeland health, the landowner performs the monitoring of the pastures in a key area within the private land in the pasture. Mixed ownerships in some pastures creates a challenge to identify a suitable location on private land to monitor grazing use. Preferred monitoring locations on these large pastures should have a stand of grasses, forbs, or shrubs in relatively good condition. This poster describes one approach to locating appropriate monitoring locations in this landscape of diverse ownerships.

0449

Yield Response of Summer-Dormant and -Active Tall Fescue to Stockpiling

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The Samuel Roberts Noble Foundation, Ardmore, OK, United States

Tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh. = *Schedonorus arundinaceus* (Schreb.) Dumort.] from Mediterranean regions has the potential to be more adapted to the southern Great Plains region because of a summer dormancy trait. A study was established near Ardmore, OK. on a silt loam soil to compare yield of Flecha summer-dormant tall fescue against the summer-active tall fescue types: Ky 31+, Jesup MaxQ and PDF AR584. Secondary objectives were to evaluate nitrogen rate (0, 60, 120, 180 lbs/ac) and harvest date (November to May 2008-2010) on yield. Two harvests were conducted each year for the November to April harvest dates. The first harvest (harvest 1) was made approximately the 15th of each month. A second harvest of re-growth was taken on the November to April plots in May. This re-growth was added to harvest 1 yield for total yield (total). Year had a significant influence on harvest 1 and total yield. In both years forage mass deteriorated during the winter months. Harvest 1 yield and total yield was influenced by variety, harvest month, and nitrogen in both years of the study. A month x variety interaction was present for harvest 1 and total yield in both years of the study. A nitrogen x month interaction occurred in harvest 1 for both years but not total yield.

0450

Competitive Effects of Canada Goldenrod on Grass Production in the Northern Tallgrass Praire

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Canada goldenrod (*Solidago canadensis* L.) is a native perennial forb that can become weedy and reduce forage production. The objective of this study was to evaluate the competitive effects of Canada goldenrod and grasses have on each other. Two native grassland sites were selected in eastern South Dakota. A total of 10 replications of four clipping treatments (clip grass-only, clip goldenrod-only, all vegetation clip, no-clip) were applied at a low density goldenrod site and 6 replications of the same treatments at a high density goldenrod site. Plot size was 1-m² per treatment. Canada goldenrod stem densities were determined before treatments were applied on May 27. The all vegetation clip treatment occurred on June 1, and the grass-only and goldenrod-only treatments occurred on June 1 and June 24. All plots were clipped for biomass estimation on August 16 and sorted by grass, forbs, and goldenrod. Data were analyzed using ANOVA and regression. The clip goldenrod-only treatment did not increase grass biomass compared to the no-clip control at both sites. The clip grass-only treatment did not increase the goldenrod biomass compared to the no-clip treatment at both sites. There was a significant negative relationship ($y = -0.59x + 312$; $r^2 = 0.52$) between goldenrod biomass on grass biomass when both sites were combined. However, the low density site had no relationship between goldenrod biomass and grass biomass ($y = -0.11x + 263$; $r^2 = 0.02$). Perhaps the competitive effects between grass and Canada goldenrod are small, but cumulative overtime to cause substantial changes in production of either species.

0451

Soil Salinity and CRP in South Dakota

Stan Boltz¹, Jeff Hemenway¹

¹USDA NRCS, Huron, SD, United States, ²Society for Range Management, South Dakota, United States,

³American Society of Agronomy, South Dakota, United States

Soil salinity appears to be intensifying on landscapes in South Dakota. This process of salinization is reducing or eliminating all agricultural production on the affected areas. One of the most cost effective alternatives in remediation of these areas is perennial vegetation establishment with enrollment of the area into the Conservation Reserve Program. Due to the extreme saline conditions of the affected soils it is extremely difficult to physically seed and establish any type of vegetation. The objective of this project was to determine the benefits that salt tolerant grass species have long term on salt movement and remediation of saline soils. A saline area was selected in the fall of 2009 near Parkston, SD. Soils were sampled a 0 to 12 inches in selected areas and grid sampled at 0 to 1 inch over the entire area. Seventeen different grass and forb species were dormant seeded November 17, 2009 with a Truax drill in 24 x 100 foot plots. Plots were replicated 3 times and evaluated for spring emergence and mid-season growth. Soil saline conditions were grid sampled with spring emergence and mid-season growth evaluations. Early preliminary results indicate overall poor establishment with the exception of tall wheatgrass, Nuttall's alkaligrass and streambank wheatgrass. Monitored soil salinity levels have fluctuated during the growing season and appear to be relatively unchanged at this point in the project.

0452

Using the Environmental Quality Incentives Program to Address Rangeland Drought and Grazing Land Management in South Dakota

Mitch Faulkner, Shane Deranleau, Stan Boltz
USDA-NRCS, South Dakota, United States

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program administered by the Natural Resources Conservation Service (NRCS) that provides farmers and ranchers financial assistance to install or implement conservation practices. In South Dakota the EQIP assists grassland managers to be better prepared to manage for drought when it occurs, and to ensure rangelands are sustainable during and after drought. In 2009 South Dakota NRCS implemented the Grazing Land Sustainability Initiative (GSI) to provide financial and technical assistance to help managers make timely management decisions as drought conditions occur. The GSI has five primary elements: (1) grazing land managers develop drought contingency plans and evaluate drought conditions as they occur, (2) a grazing land monitoring plan is implemented, (3) grazing land utilization by livestock does not exceed 50% overall, (4) participants develop a grazing plan that ensure rangelands receive at least 45 days of deferment during the growing season and grazing periods are alternated between years, and (5) participants attend the three-day South Dakota Grazing School. Since 2009 South Dakota has worked with landowners to develop 79 EQIP-GSI contracts on almost 150,000 acres across central and western South Dakota. The GSI has increased the knowledge of landowners and NRCS staff regarding rangeland and drought management, facilitated closer working relationships between NRCS staff and grassland managers, increased land owner education with improved participation in the South Dakota Grazing School, and has resulted in the development of new and innovative technical rangeland tools in South Dakota.

0453

New Rangeland and Pasture Herbicide Product Formulations from Dow AgroSciences LLC.

Vernon Langston, Pat Burch, Chad Cummings, Bill Kline, Byron Sleugh, Mary Halstvedt, Vanelle Peterson

Dow AgroSciences LLC, Indianapolis, IN, United States

Dow AgroSciences has an extensive portfolio of herbicide products for rangeland and pastures. Recent additions include the product line containing aminopyralid. This premium product line includes Milestone[®] herbicide which is designed for invasive herbaceous weed management. For premium broad spectrum control that includes residual control of later emerging weeds, ForeFront[®] R&P and GrazonNext[®] herbicides contain aminopyralid and 2,4-D. These products provide control of many broadleaf weeds in rangeland and pastures and, when tank-mixed with Remedy[®] Ultra and PastureGard[®] herbicides will also control woody plants. A new addition to the aminopyralid portfolio is PasturAll[®] herbicide for use where residual control of weeds is not needed. PasturAll contains 1.5% aminopyralid and 51.6% 2,4-D amine per gallon. Maximum labeled use rate for rangelands and pastures is 3 pints of product per acre and typical use rate for most broadleaf weed complexes will be 2 pints product/acre. Extensive research over several years has demonstrated that PasturAll provides weed control equivalent to 2,4-D ester with reduced volatility. [®]Trademark of Dow AgroSciences LLC; ForeFront R&P, GrazonNext, Milestone, and PasturAll are not registered for sale or use in all states. Contact your state pesticide regulatory agency to determine if a product is registered for sale or use in your state. State restrictions on the sale and use of Remedy Ultra apply. Consult the label before purchase or use for full details. Always read and follow label directions.

0454

Birdsfoot Trefoil a non-bloating legume and Average Daily Gain in Cattle

Lance Pitcher

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Birdsfoot trefoil (BFT) is a tap rooted, perennial, non-bloating forage legume. It has a high nutrient value and is well suited for grazing. It grows well in the dry, cool climate and higher pH soils of the northern Mountain West. A study was conducted to assess the liveweight gain (LWG) in cattle. Fall born cattle fed alfalfa (*Medicago sativa*) hay and corn (*Zea mays*) silage from weaning grazed pastures with either tannin-containing Norcen or Oberhaunstadter BFT or non-tannin-containing Monarch cicer milkvetch (CMV). Data was collected for two consecutive years with different grazing periods. Average daily gains ranged from 1.5-2.6 lbs/day for CMV and 2.4-5.2 lbs/day for BFT. More research is needed with BFT to determine the true value it can play in livestock production, given the fact that it has the potential to mitigate nitrogen and methane emissions, and average daily gains are similar to feedlot rates as shown in this study.

0455

Modeling Seedling Root Growth in Relation to Temperature for Fire Rehabilitation Species

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Fire suppression, brush control programs, the expansion of pygmy conifers and cheatgrass, and associated increases in severity, frequency, and extent of wildfire have all contributed to a decline in sagebrush communities. Wildfire results in dominance by cheatgrass unless residual species or species seeded in fire rehabilitation are abundant. Seedling establishment on semi-arid rangelands may be limited by seedling mortality after germination. As part of developing a seedling establishment model to help evaluate the potential success of plant materials for fire rehabilitation seeding, we are measuring the effects of cumulative temperature on seminal root growth. For 14 wildland species, including 6 forbs, 5 perennial grasses, and 3 cheatgrass collections we measured root growth in slanted transparent tubes in a growth chamber programmed at 6 constant temperatures (5, 10, 15, 20, 25, and 30° C). We developed equations to estimate progress and time to 15 cm root depth in the same way that we have estimated time to germination of seed populations. We then measured root growth in the growth chamber for 2 diurnally- fluctuating temperature regimes representative of early and late spring soil temperatures on sagebrush rangelands. Our initial results indicate that, for many species, root growth is most constrained by temperatures < 15 ° C. We will report how well our model predicts root growth compared to actual root growth under diurnally-fluctuating temperatures.

0456

Improving Grass Establishment on Disturbed Sites Using Mycorrhizae

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Establishment of perennial grass stands on poor substrate within a year or two of planting is a challenge faced by the Nebraska Department of Roads (NDOR). Our research focused on the impact of soil mycorrhizae additions on establishment rates of seeded perennial grasses. Research was conducted in two parts: greenhouse and roadside studies. The greenhouse study was conducted in 2010 at the University of Nebraska-Lincoln using a 2x3x4 factorial design. Treatments applied to pots of sand or clay subsoil were one of three mycorrhizae treatments and one of four organic matter (OM) treatments. Pots were then seeded to *Panicum virgatum* and allowed three months growth with ample water before harvesting aboveground biomass. The roadside study was conducted along U.S. Highway 66 near Ashland, NE with a 2x2x2 factorial design. The seed bed was prepared with composted manure or no treatment, mycorrhizae application or no treatment, and fertilizer application or no treatment. Seeding occurred in June 2010 with a native grass and forb mixture and evaluated for frequency of occurrence and harvested for aboveground biomass in September 2010. In the greenhouse study, aboveground biomass was greater ($P<0.05$) for the sand pots (0.51g) than clay pots (0.36g), and greater ($P<0.05$) for composted manure pots than other OM pots. In the roadside study, aboveground biomass of seeded species was 29% greater on mycorrhizae-treated plots than non-mycorrhizae-plots, whereas manure-treated plots favored non-seeded species. This study shows mycorrhizae applications have the potential to improve seeding establishments for NDOR and may be an applicable treatment option.

0457

Predicting the Spread of Invasive Plant Species Under a Rangeland Climate Change Scenario

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The Bunchgrass biogeoclimatic zone in British Columbia is critical rangeland habitat, but its health has been threatened by the invasion of exotic plant species for several decades. Exotics can reduce the biodiversity of important native grasses and forbs. The objective of this study was to quantify and summarize relationships between soil properties, vegetation, and topography in order to make predictions about the future movement of exotic plant species. Data were collected on 38 sites in Lac du Bois Provincial Park near Kamloops, BC over the period 2006-2010. The area surveyed ranges from approximately 400 m to 1000 m in elevation and encompasses 3 distinct plant/climate/soil communities. Vegetation cover was estimated on each site along 4, 30-m long transects laid out 5 meters apart. Soil samples were collected at 0 - 7.5 cm depth for determination of bulk density, aggregate stability, total C and N, pH, and available P at each site. In addition, slope, aspect, elevation and lat/long coordinates were recorded. Total species richness for all sites was 110, about 20% of which are exotic species. Using the gradient in climate for different elevations and aspects as a surrogate for climate change, the data were analyzed using multivariate statistics and current climate change models. Then the likelihood of future exotic species movement in the Lac du Bois region was predicted, based on "preferred" site characteristics. This approach may be useful as part of a proactive management plan for maintaining the health of native rangelands.

0458

Composition and Quality of Diets of Sheep Grazing Sulfur Cinquefoil Infested Rangeland in Western Montana

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Sulfur cinquefoil (*Potentilla recta*) is a perennial invasive forb that is adapted to nearly every soil type and vegetation complex in the western U.S. The purpose of this study was to assess the composition and quality of sheep diets grazing sulfur cinquefoil infested rangeland to evaluate the potential for targeted sheep grazing to suppress sulfur cinquefoil. Treatments were sheep grazing with and without protein supplementation applied at two timings: late June (sulfur cinquefoil in flower stage) and mid-July (sulfur cinquefoil in seedset stage). Preliminary results indicate that neither protein supplementation nor timing of grazing influenced the botanical composition of sheep diets. Sheep diets averaged 44% sulfur cinquefoil and 23% perennial grasses. In Year 1, supplemented sheep avoided perennial grasses in July and preferred sulfur cinquefoil in both June and July. Sheep selected diets higher in crude protein (CP) in June than July and unsupplemented sheep selected forage higher in CP than supplemented sheep. There was no difference in the NDF or ADF of forage diets selected by sheep. Initial results indicate that sheep readily consume sulfur cinquefoil, however protein supplementation may be necessary to maintain production on sulfur cinquefoil infested rangelands.

0459

Transcending Communication Borders in Range Management

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Arizona has a vast and diverse landscape with up to 92% of land classified as rangeland. Statewide rainfall varies from 2- 40 inches per year combined with an elevational range from the 70 ft to 12,500 ft with vegetation communities from desert grasslands to alpine forests. Administrative diversity is also high with Arizona land being managed by federal and state agencies, private entities and Indian tribes. Arizona ranchers usually have at least one federal or state lease and two or more agency allotments. The great diversity of Arizona landscapes presents great challenges in making rangeland management decisions that promote healthy rangeland ecosystems. With such a high value on Arizona's diverse landscape, the agencies that manage these landscapes must come together to preserve the sustainability of Arizona's range land. The Bureau of Land Management and the University of Arizona have formed a partnership to ensure the conservation and healthful management of Arizona lands. Working together, along with Arizona Game and Fish and private ranchers, has allowed for more informed management decisions, open communication and a better working relationship between state and federal agencies and independent ranch owners all in the best interest of native plants, animals and range. Ranchers are given the opportunity to contribute to monitoring scheduling as well as to join BLM, U.A. and AZG&F in the monitoring of their allotment. U.A. also hosts workshops and trainings to keep monitoring consistent. Transcending these communication borders will hopefully yield a well managed and healthy rangeland for both livestock and wildlife.

0460

Investigating the Soil Microbial Community Structure Under Reclaimed Roads in North Dakota

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Road construction for mineral exploration and extraction in the Little Missouri National Grasslands (LMNG) has produced thousands of miles of roads and utility corridors. Such roads are to be reclaimed to pre-construction vegetative biodiversity as described by the US Forest Service as part of the Federal Multiple Use Sustained Yield Act of 1960. Two decades after reclamation, neither vegetation nor soil physical and chemical properties of the roads have returned to conditions of adjacent native prairie. Previous studies have confirmed significantly lower levels of soil organic matter (SOM) on the reclaimed roads. Other researchers have correlated decreased SOM with reduced microbial biomass, changes in microbial community composition, and changes in enzyme activity. Decreased SOM may have led to differences in the microbial ecology of the sites. Contemporary microbial community structure will be determined using phospholipid fatty acid analysis. Other measurements include microbial biomass carbon to determine relative magnitude of the on- and off-road communities; enzyme activity will enumerate the nutrient cycling status of the soil populations. Samples were collected in close proximity to sites from preceding studies to include vegetation, physical, and chemical data in the analysis. The ultimate goal of the study is to use multivariate analysis techniques to identify and rank vegetative, soil physical, chemical, and biological properties that serve as indicators of restoration success.

0461

The Socioeconomic Impact of Climate Change on Ranching in BC

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Increased human and livestock populations in the last two centuries have significantly increased pressure on much of the world's grazing lands. Ranches in BC occupy over five million acres of private land and have tenure on 21.5 million acres of Crown rangeland, with the average ranch size being 1,074 acres. The high degree of geographical variation in BC makes it an ideal location to examine the socioeconomic effects of climate change on ranching. As of January 1 2010, inventories of cattle reached their lowest level in 15 years. In light of the current declining trends in BC's cattle industry it is vital that range managers increase their adaptive capacity to deal with variability introduced by changes in climate. Undertaking a socioeconomic analysis of the ranching industry through the lens of climate change will provide a more comprehensive assessment of adaptive capacity via the inclusion of stakeholder observation. To be consequential, this assessment must take into consideration the differences between urban and rural communities in BC in terms of local policies, growth patterns, planning issues and social attitudes. Coded questionnaires will be sent to 650 cattle ranchers in BC. The questionnaires will be coded so as to identify any response differences and attempt to determine if location influences response type or tone. It is expected that next to issues related to water quality and availability, feed prices and market prices for beef will increase livestock producer vulnerability and influence their relative ability to adapt to changes in climate.

0462

Calibrating Grid Sample Size and Comparison of Sagebrush Rangeland Cover from Aerial and Ground Images in SamplePoint

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SamplePoint is used to compute point cover values from ground and aerial imagery. Primary advantages of SamplePoint over traditional field-intensive methods include rapid data collection and the ability to archive images for processing. These advantages suggest SamplePoint is economical to use, providing application to imagery collected at small and large scales. The purpose of our study was to evaluate 1-m² ground images and 12-m² aerial images from Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)-dominated rangeland in Natrona County, Wyoming collected in June 2010 to identify important sampling relationships between small and large scale images using SamplePoint. We identified cover for annual grasses, bare ground, food forbs, litter, non-food forbs, other shrubs, perennial graminoids, shadow, unknown, and Wyoming big sagebrush to classify images. Our first objective was to compare variability (confidence intervals and coefficients of variation) between 25-point and 100-point grid ground imagery to assess efficiency in sample processing. We predicted fewer data points leads to greater variability, however, the increase in variability with fewer points may be offset by using less time to analyze more images across a larger area. Our second objective was to evaluate whether aerial photos were comparable to ground photos in quantifying cover and to estimate differences in variability between each method. We predicted that overlapping confidence intervals and large similarity index values suggest that the results from both scales taken at high resolution are similar. To obtain data for our second objective, we analyzed cover and variability between aerial and ground photography with a 100-point grid.

0463

Hope On The Range: A Great Basin Educational Project

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Hope on the Range in the Great Basin is a cooperative educational program designed to provide information about rangeland science and the art of rangeland management. This program's goal is to inform the general public about the realities of natural resources and the multiple use concept. This information will provide a realistic account of the production of food, fiber and minerals in the Great Basin. Through display of a collection of posters and handout materials by rangeland management and educational professionals, primarily at urban venues, credible information will be delivered to the public to dispel the misinformation and popular myths that are often associated with the management and stewardship of our western rangelands. Armed with credible information, we anticipate that the general public will support continued wise and sustainable uses of our rangelands under proper and timely management, which are vital to our nation's future viability. Mechanically, the Hope on the Range in the Great Basin educational display trailer is modeled after the successful UNCE Beef Quality Assurance display (BQA) trailer, which effectively reached tens of thousands throughout the U.S. Each display will tell a story about rangeland resources, covering relevant subjects such as what rangelands are and why they are important, Cooperative Conservation, wild horse management, multiple use of public lands, wildfire reduction through active vegetation management, wildlife and riparian area management, the role of the ruminant on our rangelands, plant life cycles and others.

0464

Estimating Seed Production and Plant Age of Mountain Big Sagebrush (*Artemisia tridentata* ssp. *vaseyana*)

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Seed production of mountain big sagebrush (*Artemisia tridentata* ssp *vaseyana*) is an important component of site recovery following a disturbance. It may also be a useful indicator of ecological resiliency, site condition, and stability. The purpose of this study was to develop a method for rapidly and accurately predicting seed production and sagebrush age using non-destructive field-based measurements. To predict seed production, we collected a total of 750 sagebrush inflorescences from five different sites in central and southcentral Utah. Along with obtaining a count of seeds per inflorescence, we also measured a suite of other characteristics (variables) of the inflorescence to determine if any significant correlations could be identified. To predict age, we harvested 156 sagebrush and tested the relationship between actual age with plant height, crown diameter, and several other variables. We used regression analysis to test for associations between all variables and total seed production and age. For seed production, the strongest correlation was between inflorescence weight and seed production. We found no significant associations between sagebrush age and any of the variables sampled. In 2011, the results from this study will be used to assess the response of sagebrush and seed production to fire throughout Utah. In doing so we hope to be able to predict when a site's seed bank will be at its peak, therefore allowing managers to manage mountain big sagebrush dominated communities for optimal seed production and seed bank establishment.

0465

Using the ^{15}N Natural Abundance Method to Determine N_2 -fixation in Russet Buffaloberry in Colorado

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Russet buffaloberry (*Shepherdia canadensis* (L.) Nutt.) is an actinorhizal shrub capable of forming a symbiotic relationship with the N_2 -fixing soil actinomycetes Frankia. Actinorhizal shrubs are important species as they are able to fix an ecologically significant amount of N. Buffaloberry is commonly found as a dominant understory species in lodgepole pine (*Pinus contorta* Douglas ex Loudon) communities and is a common post-fire species. There have been no studies examining buffaloberry's ability to fix atmospheric N_2 symbiotically in Colorado forests. This study used the ^{15}N natural abundance method in a survey of buffaloberry in north central Colorado to determine if it in fact fixes atmospheric N_2 and how fixation may be affected by local environmental factors. The mountain pine beetle epidemic is currently responsible for large losses in lodgepole pine forests. As the overstory canopies of lodgepole pine communities die off, there will be an increase in light availability in the understory. We investigated buffaloberry's response to light availability because with more photosynthetic activity, buffaloberry could potentially have more energy to expend in the energy intensive N_2 -fixation process. Buffaloberry had a ^{15}N abundance closer to the atmospheric standard with high foliar N content as compared to the non- N_2 -fixing reference species, indicating biological N_2 -fixation. There was no relationship between light availability and N_2 -fixation by buffaloberry. The soil $\delta^{15}\text{N}$ was not different enough from the atmospheric standard in some cases, making the isotopic signature of N_2 -fixation difficult to detect. However, this study is the first to demonstrate N_2 -fixation by buffaloberry in Colorado.

0466

SRM Section Youth Contact Workshop

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This workshop is intended to help SRM Section Youth Contacts learn from the successes and failures of other Section youth outreach efforts and more rapidly improve youth outreach in their own SRM Section. Several Sections have not had any High School Youth Forum representation for several years. There also appears to be a decline in the number of youth range camps that are being held, and the attendance has become stagnant in some regions. We hope this workshop will stimulate coordinated efforts to find solutions to some of these issues by providing an opportunity for individuals that are involved to share ideas, discuss concerns, and increase effectiveness.

0467

Forage Kochia (*Kochia prostrata*): Rangeland Rehabilitator or Exotic Invader?

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What ecological implications are associated with the introduction of a highly competitive, non-native plant species for management purposes? What potential costs and benefits should be considered when selecting species for widespread seeding? Land managers faced with the restoration and rehabilitation of the highly-degraded, exotic species-invaded, sagebrush steppe in the Great Basin of the western U.S. need answers to these questions. We addressed these issues by studying the invasion potential of forage kochia (*Kochia prostrata* [L.] Schrad); an introduced species widely seeded throughout the western rangelands to stabilize soils, provide fuel breaks and forage, and compete with invasive annual plant species. We conducted a field study on 28 Bureau of Land Management post-fire rehabilitation and greenstripping sites throughout southern Idaho's Snake River Plain to determine if forage kochia had spread from seeded sites, to what extent, and under what circumstances. Over 3 to 24 years since seeding, forage kochia spread from 0 to 710 m from the seeding boundary (mean rate = 25 m/yr). The mean distance to the recruitment margin (unseeded area with forage kochia density $\geq 1/m^2$) was 30 m. Results suggest that forage kochia may compete with cheatgrass (*Bromus tectorum* L.), as well as with native perennial species such as Sandberg bluegrass (*Poa secunda* J. Presl). Modeling to describe environmental factors correlated with rates of spread is underway. Results contribute to the current understanding of the ecological implications associated with the use of forage kochia in rehabilitation efforts throughout western rangelands.

0468

Ecology of Biotic Soil Crust Lichens of Oregon's Sagebrush Steppe

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Biotic soil crusts contribute to arid ecosystems by stabilizing soil surfaces, reducing erosion, adding soil nitrogen, and potentially discouraging invasion by exotic annual grasses. Although some of their ecosystem functions are understood, soil crust biodiversity has been poorly characterized. We searched for soil crust lichens on 59 random and 21 targeted one-acre plots in central Oregon's sagebrush steppe habitats and combined our data with herbarium records to catalog the region's diversity, determine which species are of conservation concern, and describe habitat associations of those species. We found 121 lichen species, of which 36 were considered to be of conservation concern because they were uncommon in our plots and are not known to be common on other substrates. Five of these species were previously unknown from Oregon or North America. Although previous studies have suggested that grazing and fire disturbances are strong determinants of soil crust development within restricted study areas, we found that environmental gradients such as vegetation type, soil pH, temperature and rainfall were the dominant landscape-level factors structuring soil crust lichen community composition. We describe these environmental gradients and their associated soil crust lichen communities. We also develop models for soil crust species richness and presence of rare species and map these potential soil crust hotspots. We anticipate that these results will contribute to a greater understanding of the relative rarity of soil crust lichen species and habitat factors that contribute to their abundance and diversity.

0469

The Importance of Education in Managing Invasive Plant Species

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Invasive plant species can establish in diverse environments and with the increase in human mobility, they are no longer restricted to isolated pockets in remote parts of the world. Clearly, the effects of invasive plant species have reached global scales and their related costs have been estimated in the billions of dollars. The question that has not adequately been addressed is whether landowners and managers are making significant progress in managing invasive plant species populations. One way to indirectly address the rapid advancement of invasive plant species is through awareness and education. Opportunities are needed to provide land owners and managers with the basic principles and practices related to invasive plant ecology and management. In addition, policy makers and the public need to be made aware of the seriousness of invasive plant species. Several short courses that focus on or include invasive plant species have been developed recently and could play a major role in educating individuals with broad backgrounds and experiences. Maybe it is time to take a page out of one of the most successful public service announcements from the US Forest Service, which reminds us that "only you can prevent forest fires".