Nevada Agricultural Experiment Station
University of Nevada, Reno

2012 Annual WERA 40 Report
October 4-5, 2012; Laramie, Wyoming

October 4, 2012 Field Trip
Attendees:
Doug Ramsey USU
Mike Borman OSU
Mike Smith UW
John Tanaka UW
Barry Perryman UNR
Maria Fernandez-Gimenez CSU

October 5, 2012 Business Meeting
Attendees:
Emily Kachergis ARS
Doug Ramsey USU
Mike Bourland OSU
Mike Smith UW
Barry Perryman UNR
Maria Fernandez-Gimenez CSU

Discussion of 2013 annual meeting place and time lead to determination of southern Nevada as the next area of interest. Las Vegas would be the destination and University of Nevada-Reno would be the host. Barry Perryman was elected Secretary for the 2012 meeting and Chair of the 2013 meeting.

The CMTE discussed and reviewed electronic state and transition model gaming software developed by CSU, designed to teach State & Transition Models to land managers and producers. Discussion centered around dissemination of this educational tool. The CMTE also discussed the possibility of archiving digital photographs of landscape features with global locations embedded into the stored information. The CMTE members agreed to provide electronic photographs to an archive hosted by Utah State University. It was determined that The CMTE would host a roundtable discussion with land management agency staff (including BLM, DOD etc.) regarding the incorporation of S&T models in future federal/state planning documents and their implementation in current documents that have no authorization for their incorporation, at the 2013 WERA40 mtg. The CMTE will also investigate the potential for introducing S&T to the FFA teachers involved in the 2013 and 2014 National Range Judging

Contests to be held in Wyoming and Nevada, respectively. Doug Ramsey will investigate linking the current outputs (e.g., the S&T gaming software) to the WERA 40 web site.

Direct outputs from WERA 40 (Colorado State University contribution) included:

1) State & Transition gaming software for livestock producers and other relevant publics

2) Journal article: An Assessment of State-and-Transition Models: Perceptions Following Two Decades of Development and Implementation
Author(s): Corrine N. Knapp, Maria E. Fernandez-Gimenez, David D. Briske, Brandon T. Bestelmeyer and X. Ben Wu
Source: Rangeland Ecology & Management, 64(6):598-606. 2011.
Published By: Society for Range Management
DOI:
URL: http://www.bioone.org/doi/full/10.2111/REM-D-10-00188.1

Oral state experiment station report summaries were provided from each representative. The following are the written versions:

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Oregon State University WERA 40 - Annual Report 2012

In 2012 the Department of Rangeland Ecology and Management merged with the Department of Animal Sciences to form the Department of Animal and Rangeland Sciences.

The College of Agricultural Sciences has a branch program located at Eastern Oregon University in La Grande. The Rangeland Sciences program is nested within the OSU Agricultural Sciences program at EOU. Thus, the Rangeland Sciences program within the Animal and Rangeland Sciences department is located both in Corvallis at the main campus and in La Grande on the EOU campus.

The Rangeland Sciences program has 16 undergraduate students at the Corvallis campus and 65 undergraduate students in the Agricultural Sciences program at the EOU campus. Rangeland Sciences has 4 Ph.D. and 3 M.S. graduate students, all at the main campus in Corvallis.

Rangeland Sciences faculty ranks have been depleted via retirements and transfers. In 2003, we had 8 tenure-track or tenured faculty at the Corvallis campus and 2 tenured faculty at the EOU campus. In

2012 we have 2 tenured and 1 tenure-track faculty at the Corvallis campus and 1 tenure-track faculty at the EOU campus. We are currently recruiting for a tenure-track faculty position at the Corvallis campus and plan to recruit for a tenure-track faculty position at the EOU campus to begin July 2013.

Current research programs include 1) cattle behavior changes with the reintroduction of wolves, 2) tracking livestock movement patterns in and around riparian areas, 3) computer analysis of digital photographs for monitoring vegetation structure and cover from fine to coarse scales, 4) plant community and wildlife habitat responses to juniper treatments, 5) watershed scale plant community and ground water responses to juniper removal, and 6) plant physiological responses to fluctuating water tables.

Outreach (Extension) programs focus on monitoring, livestock behavior, development of Candidate Conservation Agreements with Assurances for management related to sage grouse habitat, invasive plant management strategies, comprehensive ranch management planning with a focus on reducing winter feeding, management related to weedy annual grasses, management related to juniper encroachment, juniper treatment responses, and responses to large scale fires.

State-and-Transition theory, modeling, and uses for management planning are included in most of our Rangeland Sciences courses. Our courses attract students from Natural Resources, Environmental Sciences, Forestry, Environmental Engineering, and Animal Sciences in addition to our Range majors. So, STM concepts are being disseminated among a variety of natural resources oriented students across several academic programs.

Submitted by Michael Borman, WERA 40 representative, College of Agricultural Sciences, Oregon State University. michael.borman@oregonstate.edu, 541-737-1614

Forest and Rangeland Stewardship

Colorado State University

Recent Changes

In 2011 the Department of Forest, Rangeland and Watershed Stewardship (FRWS) became the Department of Forest and Rangeland Stewardship (FRS). About a third of the former FRWS faculty joined researchers at the Natural Resources Ecology Laboratory to form the new Department of Environmental Science and Sustainability (DESS). FRS continues to train students in our focused natural resource professional programs (Forestry and Rangeland Ecology) and our broad interdisciplinary major Natural Resource Management (NRM). DESS will emphasize preparing students for careers in environmental science.

Faculty

12 tenure-track faculty, 3 with primary teaching related to rangeland ecology and management
Newly established Shell Endowed Chair in Restoration Ecology held by Dr. Mark Paschke

Education

Undergraduate Enrollment Fall	**2012**	**2011**
Forestry	124	123
Natural Resource Management	271	280
Rangeland Ecology	63	49
Total	458	452

Graduate Enrollment Fall	**2012**	**2011**
Forest Science MS	24	21
Forest Science PhD	19	17
Master of Natural Resource Stewardship	22	19
Rangeland Ecosystem Science Distance Degree	31	44
Rangeland Ecosystem Science MS	6	6
Rangeland Ecosystem Science PhD	5	7
Total	107	114
Graduate Degree Program in Ecology students advised by FRS faculty	15	18

Student Clubs and Activities

Range Ecology Club (URME exam, Plant ID contest, Rangeland Cup)
Society for American Foresters, Student Chapter
Student Fire Association
Society for Ecological Restoration, Student Guild
Natural Resource Management Club

Awards

Kristen Oles, CSU Senior, 2nd place individual 2012 URME
Tungalag Ulambayar, 2012 SRM PhD poster competition, 3rd place
CSU Rangeland Cup team, 4th place

Outreach & Engagement

- Colorado Forest Restoration Institute
- Colorado State Forest Service based in WCNR
- Center for Collaborative Conservation (cross-campus, housed in WCNR)
- Extension Range Specialist (Roy Roath) retired in 2011. The new model for engagement is for all faculty to participate in outreach, with few or no exclusively Extension appointments. Three range-related specialists have been hired to serve different regions of the state and are based in those regions. Two of these three positions focus on small acreage management and one is a more general range management position.
- Recent grants have included funding designated for rangeland "outreach coordinator"

Research

2012 total research expenditures: $3,057,398
2012 total awards received: $2,482,591

Summary of Current and Recent Rangeland Related Research by FRS Faculty

Maria E. Fernandez-Gimenez

Learning from the Land: Extending State-and-Transition Models for Adaptive Management of Wildlife Habitat on Western Rangelands. NRCS National Conservation Innovation Grant (awarded September 2012). The purpose of this project is threefold: 1) to streamline, test and evaluate the participatory development of state-and-transition models (STMs) that incorporate sage-grouse habitat conditions, 2) to demonstrate their utility for adaptive management of sage-grouse habitat and livestock production, and thereby 3) to increase awareness and adoption of STMs by ranchers while contributing to NRCS objectives of revising ecological site descriptions and promoting adaptive management and monitoring of sage-grouse habitat through the Sage-grouse Initiative (SGI). We will use a combination of workshops, field days, ecological field sampling and remote sensing, and simulation modeling to accomplish the project objetives.

Linking Management Decisions with Ecological and Economic Outcomes in Grazed Systems. USDA AFRI Rangelands (awarded September 2012, lead institution Texas A&M). This project investigates the decision making processes of ranchers and agency professionals and the relationship between the decision-making processes and ecological and economic outcomes at the ranch scale. The research will involve two novel, complimentary approaches that will build upon existing research projects. First, a large-scale (2,600 ha) collaborative grazing management experiment will be conducted at the Central Plains Experimental Range to investigate the ecological and economic outcomes from management decisions developed by a multi-stakeholder group compared to those of traditional grazing management based on season-long, moderate stocking. Second, an in-depth observational study will be conducted on 12-16 ranches on the US Forest Service Pawnee National Grasslands that have been assigned *a priori* to four categories of management intensity based upon numbers of pastures and length of graze-rest periods. We propose to evaluate decision making processes and their relationship to ecological and economic outcomes by conducting interviews, ecological monitoring and financial reviews three times a year for each of three successive years.

Linking Ecological and Economic State-and-Transition Models for Adaptive Management of Rangeland Ecosystems. NRI Managed Ecosystems. This interdisciplinary research, education and outreach project involves ecologists, human ecologists and economists in developing state and transition models of vegetation change that integrate ecological field data and local knowledge and couple these with an economic model in order to explore the feedbacks between producer decisions, ecological states and economic outcomes, with and without management for multiple ecosystem services.

Advancing Adaptive Management of Colorado's Rangelands through Participation of Scientists, Managers and Community Members. Colorado Agricultural Experiment Station. This project aims to improve understanding of the constraints to adoption of adaptive management and other innovative rangeland management practices through a study of rancher and agency social networks, development of a pilot adaptive management project, and a participatory research approach that engages scientists, managers and community members in the design and evaluation of adaptive management efforts.

Integrated Approaches for Targeted Cattle Grazing to Improve Ecosystem Services (Co-PI with Derek Bailey and Larry Torrel (NMSU) and Larry Howery (UA)) AFRI Managed Ecosystems. This project tests the effectiveness of targeted cattle grazing to improve selected ecosystem services, evaluated

the economic costs and benefits of the approach and assesses stakeholder knowledge and attitutes towards targeted grazing to develop effective outreach.

Ecological and Economic Risk Assessment Decision Tool for Management of *Bromus tectorum* Invasions (Co-PI with Cynthia Brown, Michael Coughenour, Marshal Frasier, George Beck, and Roy Roath) NRI Invasive Species. This project assesses cheatgrass response to different grazing and herbicide treatements on different soil types, develops a linked economic and ecological simulation model to explore different cheatgrass management scenarios, assesses producer and agency professionals' knowledge and management practices related to cheatgrass, and conducts outreach about cheatgrass management and control.

Increasing the Adaptive Capacity of Mongolian Livestock Herders under a Changing Climate through Rangeland Ecosystem Monitoring and Community-based Conservation. US AID. This interdisciplinary engagement and capacity building project supports training of young researchers, natural resource agency professionals and other managers, including herders, in rangeland monitoring; develops a holistic rangeland and biodiversity monitoring protocol that herders can carry out; and designs a database that could house herder- and researcher- collected data on rangeland conditions.

Does Community-based Rangeland Ecosystem Management Increase Coupled Systems' Resilience to Climate Change in Mongolia? National Science Foundation. This interdisciplinary research, education and engagement project investigates the vulnerability of Mongolian pastoral social-ecological systems to climate change and the role of community-based institutions in building resilience to climate and other changes.

Understanding Resilience in Mongolian Pastoral Social-Ecological Systems: Adapting to Disaster Before, During and After the 2010 Dzud. The World Bank. This mixed-methods social science project investigates the impacts of a recent severe winter on Mongolian herding households and communities in order to better understand the sources of vulnerability and capacities for response and adaptation at the household and community levels.

Continuity, Change and Resilience in Pyrenean Pastoral Systems. Fulbright Senior Researcher Fellowship, Spain. This interdisciplinary research project involves interviews, a short survey questionnaire, document review, and synthesis of existing ecological research, to document herders' observations of environmental change, their ecological knowledge, and the social networks through which it is transmitted, and assess the resilience of this pastoral system to climate and socio-economic changes.

Paul Meiman

Reduction of foothills larkspur abundance and toxicity on Colorado rangelands using targeted competition from seeded forbs. Colorado Agricultural Experiment Station.

- The field component of this research project is being conducted to test the effectiveness of native and benign introduced forb seed mixes for reducing the abundance of foothills larkspur.
- Herbicide treatments were added to address the question of whether or not an initial reduction in larkspur abundance was required for successful establishment of seeded forbs
- The laboratory component of this research will investigate the potential to reduce larkspur toxicity by seeding native and benign introduced forbs by quantifying alkaloid concentrations in simulated diets containing various mixtures of larkspur and other seeded species

Interpretation of hummocks relative to the condition of riparian areas and wetlands. Colorado Agricultural Experiment Station, WCNR Competitive Grants Program.
The field component of this research project was conducted to:

- explore relationships between the odds of hummock occurrence and multiple site characteristics
- describe soil temperature profiles of hummocks and interspaces at 4 wetland sites and evaluate various theories of hummock formation relative to those temperature profiles.

Surveys and interviews were conducted to determine how natural resource managers and livestock managers interpret the presence of hummocks relative to the condition of wetlands and riparian areas

Biological Resource Management in National Parks - Invasive Species Management in National Parks Beyond - Information Management & Delivery. National Park Service

- Primary objectives and efforts include:
  - maintenance and improvement of the database used to document invasive species management efforts throughout the National Park System
  - preparation of reports and briefing materials regarding invasive species management in National Parks
  - development and delivery of educational materials regarding invasive species via internal intranet and public internet sites

Jasper Wildfire Monitoring 10 Year Re-measurement. USDA Forest Service, Forest Research

- Monitor understory responses to a mixed-severity wildfire in aspen and ponderosa pine forests.
- Primary objectives and efforts include:
  - quantification and comparison of 10-year understory responses to low, moderate and high severity fire in the northern, central and southern zones of the Jasper Fire, Black Hills National Forest, SD.
  - description of understory community development between year 5 post-fire and year 10 post- fire

Mark Paschke

Surface Disturbance Restoration on the Shortgrass Steppe

In northeastern Colorado the recent discovery of significant oil and gas resources has led to unprecedented localized and distributed disturbances to the shortgrass steppe ecosystem. These disturbances are often the focal point of weed invasion and persistence. It is safe to speculate that oil and gas activity in eastern Colorado will increase in the coming years as will the need for efficient restoration practices. Thus it is imperative to find approaches that rapidly repair damaged lands and return them to areas capable of providing ecosystem goods and services for improved quality of life to local residents. This study seeks to find a general and ecologically sound prescription for restoring value to degraded rangelands in the shortgrass steppe region of eastern Colorado.

Examining the Effectiveness of Mechanical Treatments as a Restoration Technique for Mule Deer Habitat in the Piceance Basin, CO.

The goal of this study is to examine the effectiveness of mechanical treatments in improving the establishment of mule deer forage in the Piceance Basin. Within that framework the study targets these questions:

- Is seeding a diverse mix of native species necessary?
- Does mechanical thinning improve shrub establishment versus untreated stands?
- Which shrub species will be most successful?

Restoring native plants to abandoned agricultural lands and areas disturbed by oil and gas development on the Shortgrass Steppe of Northeastern Colorado.

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Restoring native weed seedbanks to control Cheatgrass invasion and persistence

Cheatgrass (Bromus tectorum L.) is an introduced annual grass that represents a major challenge to land managers in western North America. It is an aggressive invader of disturbed soils and is capable of transforming ecosystem processes in a way that results in near monotypic stands of cheatgrass over vast areas. Cheatgrass is especially threatening on mined land because surface disturbances create ideal footholds for cheatgrass invasion. Once established at a site, cheatgrass can foil reclamation efforts and make it difficult for operators to obtain bond release. Effective methods of cheatgrass control often involve the use of herbicides, which can be nonselective and damage desired reclamation species. The plant species that are typically planted in mined land reclamations tend to be mid- and late-seral grass species with lesser amounts of late-seral shrub or forb species. These taxa often do not compete well with cheatgrass, which is a ruderal. This often leads to further dominance of cheatgrass on these early-seral disturbed soils. The list of tools available to combat cheatgrass in mined land reclamation is thus very limited.

Our current field study is exploring an innovative approach to the control and management of cheatgrass on disturbed sites. Our approach is based on successional theory and focuses on improving ecosystem health in order to resist the invasion and dominance of cheatgrass on surface mined lands in the western US. Our specific objective is to determine if restoration of native ruderal seed banks can be used to suppress the establishment and persistence of cheatgrass and facilitate establishment of native perennials on disturbed soils. We predict that restoring the seed bank of native ruderal species on a disturbed soil will result in the competitive reduction and or exclusion of cheatgrass. Since native ruderal species share many of the same ecological characteristics as cheatgrass, an exotic ruderal species, we predict they will provide more direct competition with cheatgrass. Furthermore, ecosystem succession involves processes of facilitation whereby early-seral plants prepare the site for later-seral species. By following the natural assembly rules of the ecosystem, we predict that native reclamation species can be established where the native ruderal seed bank has been restored in adequate densities to resist reinvasion by cheatgrass.

If this approach is successful, it will represent a new paradigm of invasive species control where emphasis is placed on restoring natural successional processes as opposed to the currently accepted single-species management approach that focuses on eliminating the weed problem. This could result in substantial cost savings to the surface-mining industry by reducing reclamation failures and improving bond release success.

Long Term Vegetation Dynamics and Reclamation of Land Impacted by Energy Development in the Piceance Basin, Colorado.

The overall objective of this project is to study the long-term effects of various reclamation practices on ecosystem development associated with disturbed oil shale lands in the Piceance Basin of northwestern Colorado. In 1976 a large interdisciplinary research project was initiated in the Piceance Basin in order to provide basic and applied information that would aid in the reclamation of land disturbances associated with energy development. This effort was under the direction of Edward Redente and C. Wayne Cook at the Department of Range Science at Colorado State University. The project involved approximately ten independent field studies, which were established on a 20-ha site located near what was then the focal point of oil shale activity in the Piceance Basin. The site is at an elevation of 2042m, receives approximately 33 cm of annual precipitation, and encompasses shrubland and woodland plant communities typical of the Piceance Basin.

Since this study was established, over 35 articles in peer-reviewed scientific journals have resulted. Results from these studies have led to many practices currently used in the restoration of disturbed lands. In addition, dozens of thesis and dissertations have been produced. Many of the graduate students that have worked on studies at this site have advanced to become leaders in the fields of reclamation and restoration science.

In recent years, the Piceance Basin study site has become valuable as a unique source of long-term data on ecosystem development resulting from a variety of reclamation approaches. Many insights have been gained regarding the utility or futility of various approaches. These insights were either unapparent early on, or contradict earlier results. Both the initial and long-term findings have proven useful for making management recommendations regarding reclamation practices in semiarid ecosystems throughout the world.

Despite the value of these long-term observations, only three of the seven main studies have been inventoried in recent years. There are three studies remaining that have the potential to yield additional information regarding long-term ecological dynamics. REL staff is revisiting these studies during the 2008 and 2009 growing seasons in order to retrieve this information. Results from these studies will be compared to earlier published findings and new publications describing long-term trends will be published. In addition, at the conclusion of these field studies, REL staff will co-host (along with Shell Oil Company) a special symposium on reclamation of oil shale lands in the western US featuring results from the Piceance Basin study site.

Rehabilitating slash pile burn scars in forests of the Colorado Front Range

Ecology of Cheatgrass Mycorrhizas in Western North America Rangelands

Ecology and Physiology of Selenium Hyperaccumulator Plant Species

A Survey of Actinorhizal Shrubs in Forests and Rangelands of Colorado

Using Native Annual Cover Crops to Suppress Weedy Invasive Species in Post-fire Habitats on National Park Lands in the Western USA

Restoring Native Plant Communities in Canyon de Chelly National Monument, Arizona

Nevada Agricultural Experiment Station
University of Nevada, Reno

General Update 2012

CABNR and NAES underwent massive changes during 2010-2011. The AG Experiment Station budget was severely cut by the President and Provost. Due to timing issues in the legislature, both NAES and UNCE lost their line items in the state budget. The next legislature will consider reinstating them, but it is unclear at this time whether the President will support reinstatement. CABNR now consists of 3 departments after the dissolution of both the Resource Ecomomics and Animal Biotechnology departments. All but two Resource Econonomics faculty were terminated and these two were moved to the Economics department. Four Animal Biotechnology faculty were terminated with the remaining five merged into the Department of Nutrition to form a new department: *Agriculture, Nutrition, and Veterinary Sciences* (ANVS). One of the five has now been cut through the Cooperative Extension downsizing effort, which was a 72% budget cut. The Experiment Station took a 31% budget cut in physical 2011-12 and another 14% in 2012-13 in addition to the cuts absorbed in 2010-12. The president has also ordered additional cuts by mandating a shift from A to B contracts for all CABNR faculty. In spite of these draconian cuts to agriculture programs, things have stabilized and we are beginning to initiate faculty searches to fill program needs.

More germain to this committee, the two rangeland ecology programs from the Animal Biotechnology and Natural Resources and Environmental Sciences departments have now been combined into one interdepartmental program: *Rangeland Ecology and Management*; it is now a stand-alone program with no link to the Forestry program or to an Animal Science degree. The Department of Agriculture, Nutrition, and Veterinary Sciences is currently searching for a Rangeland Animal Nutritionist. Phone interviews have been completed and campus visits are being scheduled. The Department of Natural Resources and Environmental Sciences will be looking to fill two soil scientist positions in 2013-2014 due to retirments.

We have updated our range curriculum to meet OPM 454, CPRM, and SRM accreditation requirements, and have begun accepting new students. Drs. Barry Perryman and Sherm Swanson have been named co-directors of the new Rangeland Ecology and Management Program. The Range Club is still very active although numbers are down due to graduations and two years of not accepting new students into the Animal Science program after its termination.

Status of the Main Station Farm has stabilized. The locally grown food stakeholders stood up for CABNR and stopped the plan to sell the property. The eastside connector project is slowly moving along, meaning that a portion of the property will eventually be taken out of production. The Corps of Engineers flood project on the north end of the property is now on hold due to federal budget considerations.

Research Update:

Regulation of photosynthetic processes – NEV00341

Investigator Name(s) Last Name and Intitials)

1. Cushman, J. 2. Perryman, B.

Goals/Objectives/Expected Outputs

4) Analyze the limitations and environmental factors that influence photosynthetic productivity at the whole plant and canopy levels.

Outputs:

During this reporting period, the project has resulted in two peer-reviewed book chapters (Oliver et al., 2010; Cushman and Oliver, 2011) and one journal article (Oliver et al., 2011). Several additional journal articles are in preparation and will be reported on later. One poster presentation was given by Catherine Espinosa at the 2011 American Society of Plant Biologist (ASPB) on August 6-10, 2011 in Minneapolis, MN. Two additional poster presentations were given by Abou Yobi and Sangho Kang at the Nevada Agricultural Experiment Station Ag Field Day held on September 10, 2011 in Reno, NV. Dr. Cushman delivered two invited lectures to the following audiences: Australian Center for Plant Genomics at the University of Adelaide, Adelaide, AU on July 22, 2011 and at Syngenta, Inc. in Research Triangle Park, NC on September 22, 2011.

Outcomes/Impacts:

Three different Sporobolus species, the desiccation tolerant (DT) S. stapfianus Gandoger, and two desiccation sensitive (DS) species, S. pyramidalis (also described as S. indicus var. pyramidalis), and S. fimbriatus (Trin.) Nees. (Poaceae) were evaluated for their potential as low water use forage crops by growing them under three different irrigation regimes. S. stapfianus and S. pyramidalis were not significantly affected by increased water inputs, whereas S. fimbriatus plants were responsive to increasing water. In addition, S. stapfianus had the least biomass production, averaging about three times less than S. pyramidalis and 10 times less than S. fimbriatus. Seed production was also higher in S. fimbriatus, although no clear differences were noted among the three different watering regimes. The forage value of all species contained comparable amounts of protein, tolerable amounts of fiber, and major minerals. Protein and the mineral contents investigated met or exceeded the minimum requirements of beef cattle, with the exception of zinc that appeared low in all the three species. Moreover, all mineral values measured remained below the toxicity level for beef cattle. These results combined with low water consumption (12.33 m3) indicate that these species might be useful as low-water input forage grasses in semi-arid regions of the Western U.S. including Nevada. Unbiased metabolic profiling was used to compare a desiccation sensitive (DS, Selaginella moellendorffii), with a desiccation tolerant (DT, S. lepidophylla) species within the spike or club moss family. The fully hydrated DT species accumulated more sucrose, sugar alcohols, aromatic amino acids, flavonoids, oxidized glutathione as well as a variety of gamma-glutamyl amino acid conjugates and unknown metabolites than did the fully hydrated DS species. Of the total of 302 metabolites identified in this comparative study, 136 (45%) were novel and of these, 82% showed significant differences in abundance between the two species. Within the DT species, a total of 204 metabolites were detected across all five dehydration-rehydration (wet-dry-wet) states and 118 (47%) showed significant changes in abundance in one or more of these states. Remarkably, major sugars (e.g., sucrose, glucose, and trehalose) were found to be very abundant across all stages of the dehydration-rehydration cycle and polyols showed the greatest

abundance in the hydrated state. In contrast, nitrogen-rich amino acids and gamma-glutamyl amino acid conjugates accumulated to the greatest concentrations in the dried state. A comparison of protein expression patterns in dehydrated and hydrated S. lepidophylla has now been completed and about 75 different proteins were differentially expressed between the two states. Late embryogenesis abundant (LEA) and heat shock proteins were found to be especially abundant in the dried state. Lastly, functional testing of 10 highly expressed S. lepidophylla genes by ectopic expression in transgenic Arabidopsis is still ongoing. Several LEA proteins have been found to improved osmotic and drought tolerance and are being tested for their ability to confer drought tolerance.

Biomaterial and Biofuel uses for Chrysothamnus nauseosus (rabbitbrush) – NEV00344

Investigator Name(s) Last Name and Intitials)

1. Shintani, D. 2. Perryman, B. 3. McMahan, C. 4. Coronella, C. 5. Sheldon, J.

Goals/Objectives/Expected Outputs

Project Objectives The long term goal of this research is to develop a novel high value crop for Nevada agriculture. The immediate goal of this proposal is to evaluate rabbitbrush's potential as a commercially viable biomaterial and bioenergy crop for Nevada and the Great Basin region. The rationale for choosing rabbit brush for this research is as follows: 1) Rabbitbrush is native to the Great Basin and has evolved to thrive in Nevada's high desert environment. 2) Rabbitbrush produces significant quantities of rubber for the manufacture of tires. 3) Rabbitbrush produces large amounts of oleoresins which can be used for biodiesel applications. 4) Rabbitbrush is a highly productive woody perennial which has great potential as a renewable cellulosic feedstock for bioenergy applications. 5) Because it grows on marginal soils under dry conditions, it will not compete with current Nevada crops for resources including arable land and water. The specific objectives of this research are to 1) Evaluate the material and immunogenic properties rabbitbrush rubber. 2) Evaluate the energy content of rabbitbrush oleoresins and materials derived from whole plants and post-extraction bagasse (i.e. the fibrous material remaining after the extraction process). 3) Evaluate the feedstock potential of materials derived from whole plants and post-extraction bagasse for pyrolysis based conversion to syngas for energy production. 4) Evaluate the time required for harvested stands of rabbitbrush to regenerate rubber, oleoresin and biomass stores to preharvest levels. Research Question The goal of this research is to investigate the development of rabbitbrush into a multi-use biomaterial/bioenergy crop for Nevada. The primary research questions to be addressed through this research are: 1) Are the rubber, oleoresins and biomass materials produced in rabbitbrush of high enough quality to justify the commercial development of this plant species? 2) Can rabbitbrush be used as a feedstock for biomass thermochemical conversion applications? 3) How much time is required before significant quantities of rubber, oleoresin and cellulosic material be obtained from previously harvested stands of rabbitbrush?

Outputs:

Research: 1) In order to obtain enough material for material, biofuel and biomass analyses, we developed a plant for the pilot scale extraction of natural rubber and oleoresins from rabbitbrush. 2) We and Colleen McMahan (USDA ARS) ran a series of material properties test on rabbitbrush rubber samples obtained the large scale rubber extraction procedure described in the previous CRIS Report. a) APA 2000 Analysis: The APA 2000 analyses measures dynamic mechanical properties of polymers as a function of temperature, frequency, and strain. Our results showed that rabbitbrush rubber generated very little torque, hence very low viscosity, due to the presence of a material that melts below 100C. Upon removal of the test specimen from the dies, the material oozed out. The material has a waxy consistency, and is probably a natural product that is co-extracted with the solvent. b) Gel Content Determination: According

to current theory, the outstanding physical properties of natural rubber are due to strain-induced crystallization on deformation, which is caused by formation of a "gel" network by polymer-protein and polymer-lipid linkages. The extent of formation of this network is measured by determination of % gel. The % gel is an important determinant of polymer green strength and is thus related to the utility of specific polymers in high performance applications. Hevea rubber, the industry standard has a typical % gel value of 50 to 60%. Our analysis showed that rabbitbrush rubber contained between 25 and 50% gel. c) Gel Permeation Analyses: Gel permeation analysis is used to determine the molecular weight of the rubber polymer. High performance rubbers typically have molecular weights ranging from 500,000 to 1,000,000 daltons. The rabbitbrush rubber obtained through our large scale extraction procedure yield rubber with molecular weights averaging 650,000 daltons. This differs slightly from previous analysis of small scale rabbitbrush rubber extractions where average molecular weights of approximately 800,000 daltons were observed. It is possible that the large scale extraction procedure resulted in some polymer degradation due to harsher conditions. We have changed our large scale protocol to include an antioxidant compound in our solvent to decrease oxidative damage that can result in short rubber strands. 3) Energy Content of Rabbitbrush Biomass: We have been collaborating with Dr. Curtis Robbins from the Desert Research Institute to determine the energy content of rabbitbrush biomass prior to and after solvent extraction. For these studies, calormeteric studies were conducted on ground biomass from whole plants and solvent extracted material. The results showed that there was little difference in energy content between the pre- and post-extracted material (pre-extracted = 21.32 MJ/Kg; post-extracted 20.80 MJ/Kg). These values are similar to the energy content of commercial biomass source including Jeffery Pine (20.32 MJ/Kg) and Loblolly Pine (20.28 MJ/Kg). Events: CABNR Valley Road Field Day, Biochemistry Graduate Seminar Series, Bioenergy Journal Club, CABNR Newsletter and Website

Outcomes/Impacts:

1) We have established a pilot solvent extraction plant for rabbitbrush oleoresin/rubber production. This plant can also be used by other investigators for the extraction of valuable phytochemicals from other plant species. 2) Preliminary material analyses of rabbitbrush rubber suggest that it has potential as a source of natural rubber for industrial applications. We did however find out that additional work needs to be done to produce higher quality rubber that is devoid of contaminating non-rubber components and is less prone to polymer degradation. This will be a major focus in future work. 3) Our studies have shown that rabbitbrush biomass has energy contents that are comparable to commercial biomass sources. Furthermore we were able to show that once oleoresins and rubber are extracted, the remaining lignocellulosic baggasse maintains the majority of the energy present in the pre-extracted material. As such, the post-extacted material could be used a valuable source of biomass for energy production.

Monoterpene Detoxification By Pine Bark Beetles – NEV00374

Investigator Name(s) Last Name and Intitials)

1. Tittiger, C.

Goals/Objectives/Expected Outputs

The current proposal seeks to address a lack of information regarding the biochemistry of bark beetle-host tree interactions. The enzymes catalyzing detoxifying reactions in beetles are mostly unidentified. When these enzymes are finally known, they will serve as potential targets for species-directed management strategies. Furthermore, comparing the structures and activities of these enzymes will reveal how beetles and host trees are co-evolving. Such information can be extended to current control strategies by expanding our knowledge of how insecticide resistance may involve. Finally, these enzymes

may find commercial applications because several monoterpenoid alcohols are important additives in the food and cosmetics industries [e.g. 20]. The specific objectives of this proposal are: 1. Fully characterize Ips pini CYP9T3. 2. Characterize Ips confusus monoterpene-hydroxylating P450s. 3. Compare monoterpene-hydroxylating P450s between species. Information from this work will be published in peer-reviewed journals, and presented at national or international scientific meetings (e.g. Entomological Society of America or International Society for Chemical Ecology annual meetings). EDUCATION The project will be supervised by the P.I. and performed predominantly by a graduate student. UNR Biochemistry majors will also contribute as part of their Senior thesis work. Students involved in this project will learn a variety of molecular and biochemical lab techniques, as well as experiment planning, execution, data analysis, and presentation. The graduate student will also gain expertise in supervision and management by directing the undergraduate student(s). COMMUNITY n/a SCIENCE Our understanding of P450-mediated interactions between insects and host plant toxins is mostly due to pioneering studies of butterflies [21, 22, 29]. Those studies showed a correlation between host range and substrate specificity. Our preliminary data suggest an alternative scenario: broad range bark beetles appear to use multiple P450s with narrow substrate ranges rather than a single P450 with a broad substrate range. If confirmed, this will be an important contribution to plant-insect interactions. It will inform our understanding of how the beetles and pines continue to co-evolve. It will inform decisions and development of future targeted pest management strategies. Finally, some of the enzymes may be useful commercially in the production of odorants and flavorants in the cosmetics and food industries.

Outputs:

Biochemical experiments on various monoterpene-metabolizing cytochromes P450 were performed. Graduate and undergraduate students continue to be trained in experimental design, methods, interpretation, and presentation.

Graduate Student Years: 0.5

Outcomes/Impacts:

Objective 1: The enantiomeric ratio of ipsdienol produced from CYP9T3 was determined. Objective 2: A molecular model comparing CYP9T1 and CYP9T2 is complete. Objective 3: Three monoterpene-metabolizing P450s from two different species have been identified. Molecular modeling to map their substrate-binding domains is in progress.

Biomass and biofuel production from plants suited for Nevada's arid environment – NEV003HK

Investigator Name(s) Last Name and Intitials)

1. Shintani, D. 2. Miller, G.

Goals/Objectives/Expected Outputs

Long-term project goals: The long-term goals of the proposed research are to establish the resinous arid land plant species Grindelia squarrosa (gumweed) and Euphorbia lathryis (gopherweed) as bioenergy crops for Nevada. Supporting objectives: Objective 1. Develop agronomic parameters for optimal field cultivation. Task 1. Determine minimum moisture requirements for each species Task 2. Determine minimum nitrogen, phosphorous, potassium fertilizer requirements Task 3. Determine how biomass yields are affected by water quality Task 4. Evaluate whether treatments with gibberellins and auxin can enhance the biomass production of gumweed and gopherweed. Objective 2. Characterize oleoresin fractions from each species. Task 1. Determine the developmental stage for highest oleoresin production

Task 2. Develop protocols for pilot scale extraction of oleoresins Task 3. Identify principle chemical components of oleoresin extracts Objective 3. Evaluate energy content of whole plant, oleoresin extracts, and post-extraction lignocellosic bagasse. Task 1: Perform calorimetric analyses of whole plant, oleoresin and bagasse fractions Task 2: Examine the potential of whole plant and bagasse fractions for syngas production using Biomax 15 gassifer. Task 3: Develop protocols to prepare pelletized whole plant and bagasse samples for syngas conversion.

Outputs:

The objective of this research is to evaluate arid land plant species for their utility as energy crops for Nevada and the Great Basin Region. We are in the process of developing the agronomic and processing infrastructure required to evaluate potential arid land energy crop species on a scale large enough to evaluate their commercial potential. Research: 1) We have developed a pilot plant to extract biofuel and biomaterial compounds from desert plant species. 2) Large scale garden plots were established for the controlled cultivation of potential energy crops appropriate for Nevada's arid environments. These include Euphorbia lathyris (gopherweed), Grindelia squarrosa (gumweed), Chrysothamnus nauseousus (rabbitbrush) and agave. 3) Minimal water requirements were determined for gumweed and agave. 4) Energy content determinations were performed on gumweed and rabbitbrush to determine its value as a biomass source. 5) Energy densification studies using torrefaction approaches were conducted using lignocellulosic material isolated from rabbitbrush and gumweed. 6) The chemical content and composition was determined for gumweed. 7) Established protocols to pelletize rabbitbrush and gumweed biomass. Events: CABNR Field Day; Bioenergy Journal Club; NVREC Conference Products: Establishment of pilot plant chemical extraction plant

Outcomes/Impacts:

This research will enhance Nevada's ability to compete in the area of renewable energy research by developing the expertise and infrastructure required for the pilot scale evaluation of existing and future bioenergy feedstocks. While Nevada System of Higher Education faculty are currently capable of laboratory scale processing and analyses of plant feedstocks, our ability to scale up our research is limited. As such our ability to attract funding from commercial sources is severely hampered. The primary hurdle is the lack of processing equipment capable of handling large quantities of biomass. Therefore for the proposed research we are requesting funds to purchase a pilot scale hammer mill with a 200 lb per hour capacity and a large scale solvent extractor with a 50 lb capacity.

Hydrologic and Vegetative Response to Pinyon Juniper Treatment at the Watershed Scale – NEV00742

Investigator Name(s) Last Name and Intitials)

1. Stringham, T. 2. Freese, E. 3. Weltz, M. 4. Synder, K.

Goals/Objectives/Expected Outputs

The long-term goal of this watershed scale project is to build a comprehensive understanding of the mutiple impacts of pinyon-juniper encroachment on Great Basin rangelands. Specifically, the overall project will develop predictive models of pinyon-juniper water use at the watershed scale, improve existing hillslope and watershed scale erosion models, quantify groundwater recharge from watershed scale PJ treatments and develop management prescriptions for PJ treatments aimed at improving rangeland health for multiple users. Objectives 1. Determine the amount of precipitation intercepted by trees of various sizes under four rainfall intensities. 2. Determine the amount of precipitation partitioned to stemflow by trees and whether or not stemflow benefits the tree at the expense of the understory vegetation. 3. Determine the effects of tree removal on soil moisture, evaporation, infiltration and surface

runoff. 4. Determine the effects of tree presence or removal on vegetation diversity, biomass and cover. Outputs Multiple (8 plus) journal articles and agricultural experiment station bulletins will be produced from this research. Three master level graduate thesis will be written and at least one journal publication from each thesis will be published. Additionally, agricultural experiment bulletins intended for land managers will be produced discussing the issues of water yield, soil erosion, plant production and treatment options. EDUCATION 1. Awareness of PJ impact on watershed hydrology leading to informed management decisions at the watershed scale on the projected response to PJ treatment. 2. Learning opportunities for graduate students (3) and undergraduate students (3) in research methods and data analysis. 3. Learning opportunities for public land management agencies and land managers through educational tours and workshops. 4. Information gained through this research will enhance learning materials in courses such as Rangeland Restoration and Ecohydrology. COMMUNITY 1. Increased understanding of rangeland health and the impact of PJ encroachment on ecosystem services: wildlife habitat, forage production, diversity, water yield and agriculture. 2. Increased knowledge of where and how to treat PJ stands to improve rangeland health and the desired ecosystem services. 3. Increased knowledge of the cost of treating PJ encroached rangelands. All sectors of Nevada's public, from urban to rural, stand to be impacted by the knowledge gained from this long-term, watershed scale project. Water is a scarce resource in the West and particularly in the Great Basin with demand increasing and supply declining. Many believe removal of PJ woodlands will lead to increased groundwater recharge and thus water for human use. The data gained from this project will provide scientific knowledge on the question of groundwater recharge from PJ treatment along with data on other ecosystem services impacted by pinyon-juniper encroachment. Additionally, predictive watershed scale models of potential water use and soil erosion will improve management decisions on PJ treatment options.

Outputs:

The long-term goal of this watershed scale project is to build a comprehensive understanding of the multiple impacts of pinyon-juniper encroachment on Great Basin rangelands. Outcomes for 2011 include finalization of the data collection to determine the amount of precipitation intercepted by pinyon-juniper trees of various sizes including how these trees partition rainfall into stemflow, throughfall and interception. Additionally, data collection on the effect of pinyon-juniper treatment (completed in 2009) on soil erosion utilizing small plot rainfall simulation techniques was completed. Furthermore the first year of data collection on sap flux and pre-dawn measurements were completed to determine what water source the trees are utilizing. Two field tours were completed in 2011 with particpants from the Bureau of Land Management, U.S. Forest Service, USDA Natural Resource Conservation Service, Nevada Dept. of Wildlife, U.S. Fish and Wildlife, USGS, Nevada Wilderness Society, private landowners, Congressional staff, UNR faculty and private industry. In total over 70 individuals experienced the research efforts currently underway at the Porter Canyon Experimental Watershed. Additionally, one invited presentation was given at the Great Basin Consortium first annual conference and three graduate students will present results at the Society for Range Management meetings in 2012. The rainfall interception results were presented to over 100 producers in Nevada during the January 2012 Cattlemen's Update tour. Data analysis is underway with the projected completion of two master level thesis in 2012 and two journal articles submitted by the end of 2012.

Outcomes/Impacts:

No outcomes or inpacts to report at this time.

Motivation for Private Landowner Investment to Reduce Risk and Costs of Rangeland Fires in Nevada – NEV05160A

Investigator Name(s) Last Name and Intitials)

1. Rollins, K. 2. Evans, M.

Goals/Objectives/Expected Outputs

The objectives are to better understand property-owner risk preferences and attitude towards rangeland wildfire threat, to determine to what extent Nevadans are aware of the recommended fire-safe actions that they can implement on their property to reduce the risk of losses due to rangeland wildfire, to examine the degree to which property owners have already engaged in fire-safe actions, to better understand factors that affect decisions with respect to implementing fire-safe actions, assess impacts of community characteristics (ecological, social and economic) on individuals' fire-safe actions, to examine the benefits, in general, in the agricultural and ranching communities from reduction of wildfire risk as a consequence of private actions. This information will facilitate policy-makers with the US forest Service and the BLM in the process of predicting the level of private investment in fire-safe actions which ultimately can reduce overall wildfire suppression costs on public lands.

Outputs:

During spring and summer 2011 all of the field assessments for wildfire risk were completed for a sample of residential areas located in the Wildland/Urban Interface (WUI) for communities across Nevada. Assessments included vegetation condition on private and public lands, and defensible space on private residential lots. Also included in the data set are the latitute and longitudes for each house (points taken from the road at the point were the driveway or access to private land starts). Communities sampled were chosen to represent a range of ecosystem and vegetation condition types, and community characteristics. Photographs of vegetation type and typcial streetscape and residential defensible space conditions were taken with GPS points. A total of just over 9,300 houses were assessed for deenisble space. From summer through fall of 2011, the data were cleaned, digital way points for each dwelling were moved to correspond with dwellings, using GIS maps. Tax assessor data were obtained for all counties where data were sampled. From this data, we added to our data set: owener's name and address, ownership status, lot size, assessed values, age of dwelling, and other data were obtained. Initial models were developed to evaluate criteria for determining for each observation whether the property fell into one of four categories: High-high, high level of Defensible space (DS)amidst neighbors that also exhibit high DS; high-low, high level of DS amidst neighbors that exhibit low levels of DS; low-low, low DS amidst neighbors that are also low in DS; and low-high, low ds amidst neighbors who exhibit high levels of DS. We theorize that there are multiple incentives at work that influence the choice of defensible space to create and maintain. These hypthoses are: cost of DS (both direct and indirect costs) is a private disincentive, benefits of decreased probability and cost of loss in the case of wildfire is a private incentive. The observation that others have done a lot around a given homeowner is both a strategic incentive through role-modeling and social network effects, and a strategic disincentive due to the ability to free-ride on the actions of others. The observation that others have done very little DF is a strategic incentive through the additional risk posed by neighbors to one's own property, and a strategic disincnetive through a perceived decreased sense of social pressure, and the percieved lower risk through observation of others. We plan to test these by use of spatially explicit regression analysis and by augmenting this data with data from a survey of households in the sample.

Outcomes/Impacts:

New knowledge: The four patterns described in the outputs section (High-high; high-low; low-low; low-high) are clearly observable in our preliminary analysis, and these patterns are statitically signficant. This allows us to conclude that there may be strategic interactions that innfluence homeowner's decisions to create and maintain defensible space. The next phase of the research will use the data to determine the sources of the strategic interactions as described above. The expected impacts from our findings will include recommendations to streamline and target efforts by public agencies to more effectively influence landowner decisions. For example, approaches can be tailored to communities according to the comobintations of incentives and disincentives typcial for that area.

Wild horse and burro marketing study – NEV051CR

Investigator Name(s) Last Name and Intitials)

1. Harris, T. 2. Englin, J. 3. Price, M.

Goals/Objectives/Expected Outputs

Specific objectives are: a)To estimate the value individuals place or the different characteristics of wild horses and burros offered at BLM auctions, and b)To analyze alternative auction procedures that will enhance wild horse and burro adoptions and increase auction revenues.

Outputs:

A Ph.D. dissertation was completed and accepted that investigated the potential opportunities for alternative systems of adoption for wildhorses and burros.

Outcomes/Impacts:

Results of the dissertation are currently being developed into a public document

Economics of annual grass invasion – NEV051DD

Investigator Name(s) Last Name and Intitials)

1. Rollins, K.

Goals/Objectives/Expected Outputs

To conduct an economic analysis of efforts to reduce the risk of invasive annual grasses on selected Great Basin watersheds.

Outputs:

An economic flow model that outlines in a 'how-to' apporach the steps for assessing benefits and costs of invasive weed management on western rangelands was produced. This model consists of a series of documents written to use as a web-based interactive tool that is intended for use by ARS, BLM and other agencies to evaluate costs and benefits of potential programs. The model has been submitted to the ARS's EBIPM program, where it will be set up on the program website.

Outcomes/Impacts:

The draft version of the economic flow model described in the 'Outputs' section above was used by ARS researchers as supportive material in writing a grant proposal to NIFA to fund a project that aims to improve

rangeland ecological condition (The project is described briefly at: http://www.ars.usda.gov/research/projects/projects.htm?ACCN_NO=422684 and at http://www.ars.usda.gov/is/pr/2012/120120.htm). An evaluation of the economic benefits of ARS's rangeland research on the control of invasive weeds was produced for and used by the ARS in a larger co-authored document edited by Mark Weltz and submitted to Congress to support ARS programs in the Western Great Basin. A summary of the economic models developed to measure benefits of ecological-based invasive weed management, along with results, was presented to a meeting of USDA ARS directors and stakeholders in February for use in evaluating ARS programming.

Rangeland Fires and Alternative Grazing Systems: Ranch and Regional Level Impacts – NEV051DH

Investigator Name(s) Last Name and Intitials)

1. Harris, T. 2. Swanson, S. 3. McCuin, G.

Goals/Objectives/Expected Outputs

The primary goal of the proposal is to complete a ranch and regional level analysis of the impacts of rangeland fires in Northeastern Nevada. Specific goals are: Goal 1 is o validate and update the Northeastern Nevada ranch level model. Goal 2 is to develop an integrated linear programming and Social Accounting Model for Northeastern Nevada, Goal 3 is to develop alternative grazing practices, costs of rangeland fire suppression and evaluate their impacts and costs on rangeland fires, and Goal 4 is to derive the economic and distributional impacts of rangeland fires in Northeastern Nevada from alternative production and fire suppression activities.

Outputs:

Completed a Ph.D. dissertation that investigated the procedures to develop a combined ranch level linear program and a region Social Accounting Model.

Outcomes/Impacts:

Researchers have become aware of the procedures to develop a linked ranch level linear programming and a regional Social Accounting Model.

Enhancing Ecosystem Services From Agricultural Lands: Management, Quantification, And Developing Decision Support Tools – NEV051DZ

Investigator Name(s) Last Name and Intitials)

1. rollins, K.S. 2. Kobayashi, M. 3. Taylor, M. 4. Stringham, T.

Goals/Objectives/Expected Outputs

Expected Results, Benefits, Outputs, and Outcomes Results/Outputs 1. Documentation of the common ecological framework - the state-and-transition framework - used in all of the economic studies. The document will also explain its main advantages over alternative frameworks: (1) It is consistent with the current ecological models used to represent ecological change; (2) It describes ecological conditions in a manner that corresponds with current data collection protocols by federal agencies in the western U.S. (e.g., USDA NRCS); and (3) It fits the data needs and assumption of different types of economic studies, including stochastic dynamic programming, contingent valuation, and regression analysis of wildfire

suppression costs. 2. Dissemination of research results through the ARS Area-wide project outreach efforts and the project's websites EBIPM.org. The dissemination will deliver the results of our research to: (1) rangeland scientists and other rangeland professionals that would be interested in the results of our research, but who would not necessarily be inclined to read articles in academic economics journals; (2) Rangeland professionals in the BLM, NRCS, etc., who will attend workshops put-on by the Area-wide project; and (3) Local weed management groups and ranchers who are, ultimately, the intended audience of the Area-wide project's outreach effort. 3. A suite of decision support tools designed to help land managers efficiently direct scarce resources for invasive weed treatments over space on the lands under their supervision. 4. At least 3 academic journal articles will be generated from this proposed research: (1) documentation 1 above; (2) application of the common ecological framework to address the welfare consequences of ecological change caused by invasive weeds on Great Basin watershed; and (3) development and application of our scoring methodology that assigns a score to a spatial pattern of vegetation on a landscape and evaluate policy questions related to the optimal spatial placement of invasive weed treatments on a landscape. Benefits/Outcomes 1. Empirically-sound estimates of the cost of invasion generated in this proposed study will facilitate formulating efficient public policy for invasive annuals, which requires that the expected benefits of any policy (in terms of costs avoided) be weighed against the expected costs. 2. The decision support tools developed in this study will assist managers in developing strategies that more effectively contain the spread of invasive weeds and mitigate their damages in terms of wildlife habitat loss, increased wildfire activity, increased soil erosion, and reduced grazing productivity. 3. By assisting land managers in this way, our research outputs will improve the long-run ecological health of the Great Basin and support the continued economic viability of ranching and of the agricultural communities in the Great Basin that ranching supports.

Outputs:

Developed the framework for determining scope and scale of ecosystem services to be valued for Great Basin Rangelands, for use in ex post non market valuation. Wrote an article to be published in the Western Economics Forum, that describes this framework.

Outcomes/Impacts:

Contributed to a report submitted by the Agricultural Research Service to congress that describes the need for rangeland treatment. Our part of the report provides monetary estimates of the benefits of treatments in terms of the wildfire suppression costs averted from resilient rangeland ecosystems. The impact of the contribution is that as a monetary estimate of the benefits of healthy/resilient rangeland ecosystems. These add additional context to the descriptions of the biophysical benefits contributed by other researchers, and therefore will help decision makers in Congress evaluate the benefits of these treatment projects using measurement units (dollars) that are common to other uses of these federal resources.

Characterizing Mountain Lion Distribution, Abundance, And Prey Selection In Nevada – NEV05269

Investigator Name(s) Last Name and Intitials)

1. Stewart, K. 2. Thain, D. 3. Andreasen, A.

Goals/Objectives/Expected Outputs

Goal 1: Obtain information to better manage mountain lions as a metapopulation at broad geographical scales of biological relevance. Objective 1: We will delineate genetic population structure of mountain lions throughout Nevada and determine metapopulation structure. We have over 700 tissue samples from hunter harvested mountain lions that will allow us to delineate genetic boundaries of mountain lion

populations in Nevada as well as estimate the rate of effective migration between interacting sub-populations. The results from the genetic structure analysis can be used by wildlife managers to create biologically meaningful management boundaries that incorporate the level of immigration occurring between populations. Goal 2: Gather information to help managers create scientifically sound harvest objectives. Objective 2: We will identify source and sink populations by estimating the rate and direction of effective migration between populations. Wildlife managers will then be able to create area specific, scientifically sound, harvest objectives by taking into consideration the varying amounts of immigration sustaining populations. Populations that have less immigration will be able to sustain less harvest while populations that incur a great amount of immigration from surrounding populations will be able to sustain a higher level of harvest. Information on the amount of immigration between populations is not currently available & failure of managers to consider the role of immigration in sustaining populations can lead to detrimental management errors by assuming a constant level of harvest can be sustained across the landscape. Goal 3: Maintain balance between mountain lions and prey Objective 3: To achieve the goal of maintaining balance between mountain lions and prey we are quantifying kill rates and prey selection of mountain lions in select sub-populations in Nevada. This research will be the first in Nevada that explicitly examines the diet of mountain lions. We have preliminary data that indicates that some individuals may be dietary specialists focusing predation efforts on feral horses. Particularly in multi-prey systems with novel prey items is information on predation rates and prey selection is important to determine how mountain lion's are affecting prey species and how densities of alternative prey influence mountain lion densities. OUTPUTS: Objectives 1 & 2: We will begin analyzing genetic data in the fall of 2010. We anticipate that the results pertaining to population genetic boundaries, migration across the state, and source-sink dynamics should be complete by the end of June 2011. Objective 3: We anticipate that all kill sites for at least 12 collared mountain lions will be located on the ground by June 2011. These data will include the types of prey killed, age and sex of animals killed, and body condition prey items. Kill rates and prey selection of all (24) adult mountain lions will be estimated in June 2013.

Outputs:

From Jan 1, 2011 through December 31, 2011 we performed activities that would help us achieve the objectives associated with goals one, two, and three of this project. Goal: 1.) Obtain information to better manage mountain lions as a metapopulation at broad geographical scales of biological relevance by delineating population genetic structure of mountain lions in Nevada. 2.) Gather information to help managers create scientifically sound harvest objectives by estimating movement rates between populations and identifying source and sink populations. 3.) Maintain balance between mountain lions and prey. We accomplished the first two objectives by completing modeling of the genetic structure and source-sink dynamics of mountain lion populations throughout the state of Nevada and the Sierra Nevada mountain range. We have also continued to capture mountain lions and collect data on predation rates and prey selection in the field by backtracking to GPS clusters in order to achieve goal #3. We have captured 17 additional mountain lions and visited over 600 additional predation sites since the last report was provided for this grant. We have now captured and collared a total of 37 mountain lions and visited over 1000 GPS clusters (potential predation sites). EVENTS: From January 1, 2011 to December 31, 2011 Alyson Andreasen, the PhD student working on the project, gave seven presentations to disseminate information including 3 professional conferences where she presented the preliminary results of the genetic analysis. Those professional meetings were attended to disseminate information to other scientists to increase scientific knowledge about mountain lion movement, ecology, and source-sink dynamics that may occur at the landscape scale for large mammals. These professional meetings include the Nevada Chapter of the Wildlife Society in Reno, Nevada; the 10th Mountain Lion Workshop in Bozeman, Montana; and the 91st Annual Meeting of the American Society of Mammalogists in Portland, Oregon. Alyson also was invited to give a talk and presented information about the overall project to the

Wildlife Conservation Society at their national headquarters in Bozeman, Montana. The other 3 talks were public outreach presentations to reach target audiences including an invited presentation for the Mason T. Ortiz Camp- an outdoor skills camp for kids; a local travel club that was attended by over 70 local professionals; and to the Nevada Bighorns Unlimited Sportsman's group (NBU). These talks were designed to educate the public about mountain lion ecology in Nevada and also aimed at those that live on the urban/wildand edge, how to live with mountain lions. We anticipate that these educational opportunities to the public and partners (NBU) will ultimately help increase the public's tolerance of mountain lions and reduce conflicts with humans and livestock which are of the largest threats to the long-term persistence of mountain lions today.

Outcomes/Impacts:

Significant changes in knowledge have occurred during this reporting period. Before this research, we were unaware if mountain lion populations in Nevada were genetically distinct or one panmictic population. Results of previous genetic research on mountain lions throughout the western US have been ambiguous with some studies showing population structure exists in mountain lions in noncontiguous habitat (Ernest et al. 2003; McRae et al. 2005) while others have failed to show any substructure of populations (Sinclair et al. 2001; Anderson et al. 2004). In addition, although it is recognized that identifying source and sink populations is necessary for responsible management of hunted mountain lion populations, only a few studies we are aware of have attempted to do so, and these were through extensive monitoring of a radio-collared populations (Stoner et al. 2007; Robison 2008). Furthermore, estimating movement rates in the field to identify source-sink dynamics that occur at large scales is logistically infeasible in most systems. Nonetheless, with resources provided by the Nevada Agricultural Experiment Station Hatch Grant, we were able to identify distinct genetic populations throughout Nevada and model source-sink dynamics for these mountain lion populations using recently developed Bayesian genetic techniques. We anticipate significant changes in action within the scientific community to result from this research as this is the first research that we are aware of that models source-sink dynamics of a large mammal species using a genetic approach. Finally, we anticipate changes in conditions to result from this research as the results can be used managers can create biologically meaningful management boundaries for mountain lions and develop harvest quotas that take into consideration the amount of immigration sustaining populations in different areas. We are currently finalizing a manuscript summarizing the results of these re-analyses that will be re-submitted to the journal Molecular Ecology for review in March 2012. In addition to the outcomes/impact described above resulting from genetic analysis, significant change in knowledge is occurring as a result of the field data we are collecting on prey selection of mountain lions. We are currently working on a manuscript for publication of these dietary results in a peer-reviewed journal. We anticipate that these results will be submitted for publication in the fall of 2012. We anticipate changes in actions and changes in conditions to result from this research as managers, the public, and local interest groups, gain a better understanding of the dietary patterns of mountain lions in Nevada.

Sustainability of Mowing Fuel Breaks: Resilience of Sagebrush Rangelands – NEV05272

Investigator Name(s) Last Name and Intitials)

1. Swanson, S. 2. McAdoo, K. 3. McCuin, G. 4. Schultz, B. 5. Swanson, J. 6. Leger, E. 7. Stringham, T.

Goals/Objectives/Expected Outputs

Objectives This proposal is an addition to the larger "Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin" (SymMon) project, which involves the harvesting and analysis of past wildfire and land treatment implementation, location, and monitoring data

from numerous agencies, academia, and other organizations. Using SynMon data, we will focus on specific ecological sites that are most vulnerable to loss of resiliency and change in flammability due to invasion by cheatgrass and other annuals. We will study the operational characteristics of lands subjected to ongoing multiple use management that cause them to increase resilience when treated by mowing to create fuels breaks. Or conversely, to express loss of resilience as they further transition across an irreversible threshold to cheatgrass and other invasive plants. The objectives of this study are to: 1) Compare the response of vegetation to wildfire and to mowing of sagebrush to create fuel breaks by measuring the change in cover of bare soil, litter, rock, cryptogam, basal area, % live and dead or decadent shrubs, native graminoids, introduced grasses, native forbs and exotic forbs, each by species. 2) Determine the pre-treatment conditions that predict post-treatment response. 3) Determine how these effects vary across ecological sites within the Wyoming big sagebrush zone. 4) Determine how treatment effects differ through time. 5) Search for response patterns related to ancillary factors including season, duration, or intensity of livestock use; agency horse management; other human disturbances such as off highway vehicles; weed infestations; topography or elevation; and timing of the treatment.

Outputs:

NW Nevada/NE California Field Studies (Humboldt, Pershing, Washoe, Modoc Counties). (Lead Investigator: John Swanson). Planned, coordinated and implemented field studies on 45 different wildfire and land treatment event sites. Consolidated data and shared with all collaborators. Completed the following for the data collected on the 45 NW Nevada/NE California wildfire and land treatment event sites: All data organized and entered onto digital spreadsheet. Compiled data shared with collaborators. Data arcsine-transformed for normalization purposes. Initial regression and correlation runs completed; statistically significant parameter pairs identified. Also worked with one mathematics professor and three mathematics graduate students during the preliminary analysis of the 2010 NE Nevada field data.

Outcomes/Impacts:

Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. 2010 Field Studies - NE Nevada Wyoming Big Sagebrush Event Sites. Oral presentation delivered at Science Delivery Project/Nevada Partners in Conservation Workshop: Vegetation Resilience. Winnemucca, NV. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. State and Transition Model Applications: Wildfire and Preventative Land Treatments. Oral presentation at annual meeting of the Nevada Section of SRM. Winnemucca, NV. In December, 2011, Northeastern Nevada Stewardship Group representatives invited me to give an oral presentation at their February 2012 meeting in Elko. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. 2011 Sharebook. Data base for all SynMon field data collected to date. Has been shared with all project collaborators. Swanson, J. 2011. Some SynMon Project Results. Impromptu oral presentation to NRCS, UNR participants, State and Transition Modelling Workshop. Reno, NV.

Direct And Indirect Effects Of Grazing Management On Ecohydrology And Plant Community Structure Of Seasonal Wetlands – NEV05273

Investigator Name(s) Last Name and Intitials)

1. Weisberg, P.J. 2. Saito, L.

Goals/Objectives/Expected Outputs

We propose to expand an ongoing study of the effect of livestock use on vernal pool plant communities to include an evaluation of ecohydrology. Our proposed study focuses on vernal pools, although results will be valuable for understanding interactions among livestock use, vegetation and ecohydrology for

seasonal wetlands more generally. We define "livestock use" as encompassing all direct and indirect effects of livestock activities, including herbivory, trampling, and nutrient transport. Our research will quantify the interactions among: (a) Seasonality and intensity of livestock use; (b) Inundation period and drawdown rate; (c) Distribution of plant communities within spatially heterogeneous vernal pool landscapes; and (d) Species composition, population structure, and reproductive success within selected plant communities. Our species-specific analyses focus on Orcuttia tenuis (slender Orcutt grass), an annual grass species of national conservation concern. Our analysis thus addresses multiple spatial scales and levels of ecological complexity, from individual plants and plant species, to plant community types and mosaics of plant communities within the wetland landscape. Through an improved understanding of such interactions at multiple scales, we will develop concrete recommendations for natural resource management agencies and grazing permittees concerning livestock use practices compatible with seasonal wetland plant communities and species of conservation concern. Successful completion of this project will directly addresses several of the research priorities of the Nevada Agricultural Experiment Station including 1) agricultural production in a semi-arid environment; 2) environmental sciences in a semi-arid environment; and 3) natural resource management and environmental sciences in the Great Basin and Sierran ecosystems.

Outputs:

This project complements project NEV052XG,extending our study of vernal pool plant communities to focus more explicitly on the interaction among livestock grazing management, vernal pool hydrology and plant community structure. To do so, we take advantage of small grazing exclosures placed in a number of pools, and one extensive pool that has been protected from grazing. In the last half-year we have hired a graduate student to lead the hydrologic modeling, and have contributed to the hydroperiod monitoring, pool surveys and vegetation sampling as reported for NEV052XG. Surveying equipment was used to record elevation of the bottom of the pool at each plot which was used to reconstruct water depth and inundation length for 1-m2 hydroplots and the entire vernal pool. Surveying equipment included Leica-Wild TC1010 (with one-second accuracy) Total Station, TDS (Total Data Systems) Recon with Survey Pro for windows XP (Ver. 3.8.1) Data Collector, and Ashton's rod. From water depth and elevation data, equations were used to calculate the total number of days inundated, maximum depth, and number of days over 10 cm deep for each 1-m2 hydroplot. Species composition and richness data will be used to classify dominant vernal pool vegetation types using classification and zonation methods. The combined data will allow us to relate dominant vegetation types and O. tenuis population characteristics to gradients of drawdown time and pool depth, and to model species distribution limits as a function of hydrologic gradients within each vernal pool ecosystem.

Outcomes/Impacts:

Field trips in Summer 2011 included Forest Service personnel (ecologists, botanists, and land surveyor) and facilitated knowledge exchange and idea generation.

Identifying the Incidence of Mycoplasma, Mannheimia, and Lungworm across the Genetic Landscape of Nevada's Bighorn Sheep – NEV05274

Investigator Name(s) Last Name and Intitials)

1. Matocq, M.

Goals/Objectives/Expected Outputs

Our long-term goal with this research is to identify the primary factors involved in bighorn sheep

pneumonia outbreaks in Nevada. Because simultaneous study of all potential disease factors remains outside the scope of any single project, this study focuses on three potentially closely related factors. Our research hypotheses emerge from the following overall objectives for each of these factors: Objective 1: Identify the presence or absence of Mannheimia haemolytica and Mycoplasma ovipneumoniae in apparently healthy and sick/dead sheep from Nevada. Objective 2: Identify the prevalence of lungworm infestation in apparently healthy and sick/dead sheep from Nevada. Objective 3: Quantify genetic diversity at both neutral and immunity-related genes in healthy and sick/dead sheep from Nevada. With the reduced scope of funding provided to this project, the above objectives will be met within the full 3-year project period but with smaller sample sizes than originally proposed. Data generated to address the above objectives will result in a database of individually genotyped bighorn sheep that have been screedned for disease agents and lungworm infestation.

Outputs:

The initial months of the project required coordination with the Nevada Department of Wildlife to collect field samples for this project.Approximately 15 localities and nearly 200 individual samples have been collected by the Nevada Department of Wildlife for this project and will be transferred to our lab for analyses in the coming month.

Outcomes/Impacts:

No outcomes or impacts to report at this time.

The Long-Term Effects of Thinning, Residue Mastication, and Prescribed Fire on Fuels, Soil Fertility, and Runoff Water Quality in a Mixed – NEV05275

Investigator Name(s) Last Name and Intitials)

1. Johnson, D.W. 2. Walker, R.F. 3. Miller, W.W.

Goals/Objectives/Expected Outputs

Mechanical harvest with mastication of logging residues has become a popular adaptive management strategy for fire mitigation in the Sierra Nevada, yet little is known about its long-term effects on soil fertility, forest health, or water quality. Mastication results in the conversion of large pieces of woody biomass (along with small branches and foliage) to small (2-6 cm) chips and spreading them over the treated land area. This treatment differs significantly from traditional practices where residues are left whole and often concentrated in rows or piles. Masticated woody residues have greatly increased the surface area to volume ratios of fuels, facilitating accelerated rates of decomposition in unburned stands and causing significant changes in fire behavior in burned stands. A study involving thinning plus residue mastication and prescribed fire, alone and in combination with each other, was established in a mixed conifer site in the Lake Tahoe Basin in 2003. Pre-treatment and first year post-treatment data on fuels, soil fertility, and water quality was collected (Walker, et al., in press; Loupe et al., 2009; Glass, 2006). We propose to re-enter this study after eight years and collect data again using the same protocols as before. These measurements will include 1) quantification of fuel loads, 2) measurements of forest growth and stand health, 3) measurement of soil nutrient status and long-term nutrient budgets, and 4) measurement of runoff water quality. We hypothesize that as masticated woody material decomposes after 8 years, labile nutrients in both soils and runoff waters in the masticated, unburned plots will decrease because of immobilization in high C:N ratio decomposing woody residues. This in turn could also result in reduced tree and understory growth because of reduced N availability. In the burned only and masticated plus burned plots, we hypothesize that the initial fire-induced pulse of ammonium and nitrate will have

dissipated in both soils and runoff waters after eight years, but will not decline to below levels in the untreated plots. In summary, we hypothesize that the levels of ammonium and nitrate in runoff waters and soils after eight years will occur in this order: burned, harvested > burned, unharvested > untreated > harvested.

Outputs:

All litter and soil samples were taken from the two prescribed fire study locations (Truckee and North Lake Tahoe) so that changes over eight to nine year periods can be assessed. All resin-based collectors originally used in these locations have been reinstalled for monitoring over the 2011-2012 snow season. While waiting the results of the resampling described above, we investigated the effects of rock content on nutrient concentrations and contents (kg ha-1) in the soil at the North Lake Tahoe site. Rock content to a 60 cm depth ranged from 8 to 69% among 20 quantitative soil pits within a 10 ha area. On average, rocks contained 9% of total soil C, 19% of total soil N, 3% of total ecosystem C, and 12% of total ecosystem N. Percent rock content also appeared to cause increases in organic matter concentrations: rock content was significantly, positively correlated with total C and total N concentrations in the fine earth (> 2mm) fraction. Soil C was organic; no carbonates were present. Percent rock content was also significantly, positively correlated with fine earth C:N ratio, suggesting that organic matter in rockier soils was in an earlier stage of decomposition at any given depth. Other consistent correlations with rock content included Bray P (positive) and exchangeable Mg2+ (negative). The decrease in fine earth mass with increasing percent rock content offset the increase in C concentration such that there was no correlation between percent rock content and either fine earth or total soil (fine earth plus rock) C content (kg ha-1). Percent rock content was significantly negatively correlated with total N, Bray P, inorganic N, exchangeable K+, Ca2+, and Mg2+ contents, however. The results of this study show that high rock content can affect soil C and nutrient pools not only because of the contributions of the rocks themselves, but also because high rock content appears to cause higher concentrations in the fine earth fraction. A paper describing these results has been accepted for publication by Geoderma and will be reported next year.

Graduate Student Years: 1.0

Outcomes/Impacts:

No outcomes or impacts to report at this time.

Effects of Shrubsteppe Vegetation Structure on Reproductive Success of Sage Grouse – NEV052QUA

Investigator Name(s) Last Name and Intitials)

1. Sedinger, J.

Goals/Objectives/Expected Outputs

The principal objective of this project is to understand how vegetation structure influences reproductive success of sage grouse breeding in central nevada. Shrub structure and cover combined with that of understory vegetation is hypothesized to influence nest success of sage grouse. This hypothesis has been assessed in relatively few locations, which are generally more mesic than is the case for central Nevada. Thus, the general hypothesis requires additinal assessment as does it's applicability to sage grouse in central Nevada

Outputs:

We used mark-recapture, lek observations, nest & brood monitoring, vegetation sampling, and radio telemetry to estimate key demographic parameters. A total of 1165 unique individual sage grouse have

been banded during the first eight years of the study. From 2003-2007, counts of common ravens along the transmission line corridor and raven-associated disturbances at leks increased dramatically, however, in 2008 raven counts declined to levels observed immediately following line construction, and increased but remained low in 2009 and 2010. A Program MARK known fate analysis showed that population, month, season of capture, and breeding success influenced female survival. Monthly survival was lowest during the months of September (0.92 +/- 0.02 SE) and April (0.91 +/- 0.02 SE). Survival was higher for birds associated with the Roberts Creek Mt. population than for the Cortez population, and hens that successfully fledged broods were predicted to experience lower survival than hens that did not. Females that were captured during the spring breeding season had higher annual survival than those captured during the fall trap (.591 +/- .025 SE and .541 +/- .041 SE). We conducted additional known-fate analyses to evaluate temporal, spatial and habitat impacts on fall survival. We found substantial temporal and spatial variation in fall survival both within and among years that was best characterized by trends in weekly survival. These results showed that survival tended to increase, decrease, or remain stable within populations and years, irrespective of conditions in the adjacent population or during previous years. Additionally, we evaluated data from a subset of females that were followed more closely on the ground. Habitat conditions at female locations that most influenced survival, as well as temporal patterns in predator communities responsible for female mortality, suggest that top-down forces may regulate survival of females during the fall. Nests were monitored to estimate success, with nest site vegetation characteristics measured after hatch and evaluated as covariates in a nest success analysis in Program MARK. Model results showed a population-level effect on nest success; hens from the Roberts Creek Mt. population had higher nest success than hens from the Cortez population (0.214 +/- 0.045 SE and 0.178 +/- 0.032 SE, respectively). Additionally, we found interactive effects between wildfire impacts and road density, such that nest success was lowest in areas impacted by roads, and highest in non-burned roadless areas. We used Pradel models in Program MARK to directly estimate population growth, as well as survival and seniority from male capture/recapture/resight data. Male survival varied by year, and ranged from a low of 0.568 (+/-0.06 SE) in 2006 to a high of 0.801 (+/- 0.06 SE) in 2004. A robust-design analysis of our male capture-recapture data has shown that variation in breeding propensity may be largely responsible for annual variation in lek counts. Our results continue to support demographic differences between the Roberts Creek and Cortez populations, and suggest that sage grouse in the Cortez Range are at higher risk.

Outcomes/Impacts:

This project will provide the first rigorous assessment of the effects of transmission lines on sage-grouse.

Can repeated burning of cheatgrass dominate rangelands be used to restore sagebrush steppe? – NEV052SA

Investigator Name(s) Last Name and Intitials)

1. Johnson, D. 2. Chambers, J.

Goals/Objectives/Expected Outputs

Cheatgrass (Bromus tectorum), an exotic annual grass, is rapidly expanding throughout the Great Basin. This highly competitive invader is resulting in the widespread deterioration of mid- to low elevation sagebrush ecosystems and, more recently, salt desert ecosystems (Brooks and Pyke 1991, Wisdom et al. 2005). Cheatgrass has altered fire regimes in native ecosystems because it increases fine fuels, is highly flammable, and increases the rate of fire spread (Link et al. 2006). Recent field studies have shown the importance of available inorganic nitrogen in controlling cheatgrass establishment and growth (McLendon and Redente, 1991; Young et al., 1999). Experiments with sugaring soils to stimulate microbial

competition for N, thus reducing mineral N supplies in soils have proven to severely limit cheatgrass growth and to favor native species by reducing competition (Young et al. 1999). An alternative approach to sugaring to tie up mineral N might be to reduce total N supplies and, therefore, mineral N supplies by repeated burning. On the other hand, burning commonly causes short-term increases in soil ammonium levels because of the heat-induced denaturing of soil organic N (Neary et al., 1999). The pulse of ammonium is often followed by pulse of nitrate and nitrate leaching once nitrifying bacteria occupy the site again. The short-term pulse of ammonium after fire is thought to be one factor favoring nitrophilic cheatgrass after rangeland fire (Monaco et al. 2003). Over the long-term, however, one would expect that repeated burning without replacement of lost N could cause reductions in soil mineral N levels, at least after the initial post-fire pulse has passed (Blair, 1997; Johnson and Matchett, 2001; Ojima et al., 1994). This is attributed to both volatile losses of N and also to a form of progressive N deficiency, where N concentrations in vegetation decline over time in response to reduced soil N availability, causing inputs of detritus with lowering C:N ratios. The N deficiency is further exacerbated by increasing microbial competition for N in much the same manner as the short-term sugaring experiments described above (Blair, 1997; Johnson and Matchett, 2001; Ojima et al., 1994). Although it has been shown that cheatgrass invasion can rapidly alter nitrogen cycling (Evans et al. 2001), little is know about the effects of repeated fire on nitrogen availability in cheatgrass dominated rangelands. Our objective in this study is to explore the prospects for "burning out" cheatgrass with repeated fires designed to reduce total and available soil N and, consequently, cheatgrass growth and reproduction.

Outputs:

The greenhouse experiment showed that cheatgrass exploits fire in two ways: 1) by taking up nitrogen released from soils during fire, and 2) by mining native soil nitrogen in addition to that.

Outcomes/Impacts:

Cheatgrass (Bromus tectorum L.), an invasive annual grass, is displacing native species and increasing fire frequency in the Great Basin. Growth and nitrogen uptake patterns by cheatgrass were examined in a greenhouse study using soils from sites with the same soil type but different fire histories: 1) an area that burned in 1999 that is now completely invaded with cheatgrass (CG); 2) an area that has not burned recently and is now dominated by Wyoming big sagebrush (Artemisia tridentatassp.wyomingensis Beetle and Young) and Sandberg's bluegrass (Poa secunda J. Presl) (WBS); and 3) a Wyoming big sagebrush area that burned in August of 2008 just prior to soil collection (NB). Cheatgrass seedlings had higher leaf numbers, height and mass in the NB soil. Ammonium-N mobilized by fire in the NB soil had significantly heavier 15N than soils from CG or WBS sites and this pattern was reflected in the isotopic signatures of the plants. Fire-mobilized mineral N accounted for only 58.4% of N taken up by cheatgrass in the NB soil, suggesting fire enhanced the ability of cheatgrass to mine soil organic N.

Dynamics of Sage Grouse populations in response to transmission lines in central Nevada – NEV052SM

Investigator Name(s) Last Name and Intitials)

1. Sedinger, J.

Goals/Objectives/Expected Outputs

Our goal is to continue a 10-year study of the sage grouse population in Eureka County to assess the effects of the Falcon to Gondor transmission line on the local sage-grouse population. Hall and Haney (1997) proposed three possible impacts of transmission lines on sage grouse. One impact could be a decrease in adult survival due to predation on adults. A second impact could be a reduction in nest success due to nest predation. The third impact could be increased dispersal by sage grouse due to the

perceived threat of increased predation. The study will involve monitoring of the population during the lekking, nesting and brood rearing periods. Before and during the lekking and nesting seasons birds will be captured. Leks will be monitored to estimate numbers of males using each lek and dynamics of lek size over time. We will encounter marked grouse on leks to assess movement among leks and estimate survival rates. We will also use lek counts and observations of marked individuals on leks to estimate numbers of individuals on leks and lek dynamics. A sample of females captured during this period will also be fitted with radio transmitters to assist in finding nests and monitoring movement during lekking and brood rearing and to assist in finding nests and broods. During brood rearing, females and juveniles will be located using transmitters.

Outputs:

The long-term goal of this ten-year study is to assess the impact of NV Energy's Falcon-Gondor transmission line on sage grouse demography and population dynamics. A total of 1165 unique individual sage grouse have been banded during the first eight years of the study. From 2003-2007, counts of common ravens along the transmission line corridor and raven-associated disturbances at leks increased dramatically, however, in 2008 raven counts declined to levels observed immediately following line construction, and increased but remained low in 2009 and 2010. A Program MARK known fate analysis showed that population, month, season of capture, and breeding success influenced female survival. Monthly survival was lowest during the months of September (0.92 +/- 0.02 SE) and April (0.91 +/- 0.02 SE). Survival was higher for birds associated with the Roberts Creek Mt. population than for the Cortez population, and hens that successfully fledged broods were predicted to experience lower survival than hens that did not. Females that were captured during the spring breeding season had higher annual survival than those captured during the fall trap (.591 +/- .025 SE and .541 +/- .041 SE). We found substantial temporal and spatial variation in fall survival both within and among years that was best characterized by trends in weekly survival. Survival tended to increase, decrease, or remain stable within populations and years, irrespective of conditions in the adjacent population or during previous years. Additionally, we evaluated data from a subset of females that were followed more closely on the ground. Habitat conditions at female locations that most influenced survival, as well as temporal patterns in predator communities responsible for female mortality, suggest that top-down forces may regulate survival of females during the fall. Nests were monitored to estimate success, with nest site vegetation characteristics measured after hatch and evaluated as covariates in a nest success analysis in Program MARK. Model results showed a population-level effect on nest success; hens from the Roberts Creek Mt. population had higher nest success than hens from the Cortez population (0.214 +/- 0.045 SE and 0.178 +/- 0.032 SE, respectively). Additionally, we found interactive effects between wildfire impacts and road density, such that nest success was lowest in areas impacted by roads, and highest in non-burned roadless areas. We used Pradel models in Program MARK to directly estimate population growth, as well as survival and seniority from male capture/recapture/resight data. Male survival varied by year, and ranged from a low of 0.568 (+/- 0.06 SE) in 2006 to a high of 0.801 (+/- 0.06 SE) in 2004. A robust-design analysis of our male capture-recapture data has shown that variation in breeding propensity may be largely responsible for annual variation in lek counts. Overall our results continue to support demographic differences between the Roberts Creek and Cortez populations, and suggest that sage grouse in the Cortez Range are at higher risk.

Outcomes/Impacts:

Results from this study will be the first rigorous long-term assessment of the impacts of transmission lines on sage-grouse.

Responses of mule deer to experimental manipulation of water in mojave preserve – NEV052SN

Investigator Name(s) Last Name and Intitials)

1. Stewart, K. 2. Sedinger, J.

Goals/Objectives/Expected Outputs

The purpose of this investigation is to assess responses of mule deer inhabiting the eastern Mojave Desert to the provision of water at locations where it had been, but is no longer available. Secondarily, we address interactions between mule deer and vegetation as influenced by availability of surface water. This project will test 4 hypotheses. H1: Provision of permanent, year around water will be beneficial to mule deer populations. H2: Provision of water at historic wells will not be detrimental to habitat for other wildlife species. H3: Availability and quality of forage for mule deer and other species will be greatest in areas around developed water, seeps, and springs than away from sources of water or water catchments that are not functional. H4: Mule deer will actively select for areas near permanent sources of water and home range size of mule deer will be smaller in areas with permanently available water.

Outputs:

This study is designed to investigate the effects of provision of water to the population in Mojave National Preserve. We are examining the effects of permanent sources of water on survival and productivity of mule deer. We are comparing areas with permanently available water to those where permanent sources of water are not available. We captured 15 mule deer this year and equipped them with GPS radio collars. We captured deer in March and applied GPS radio collars. We collected vegetation data in the field and located females to determine if they had young at heel. We analyzed 2 years worth of data to compare survival among our study areas. We began to disseminate information by presenting at poster presentation at the Annual Wildlife Society poster session and a oral presentation at the Nevada Chapter of the Wildlife Society Meeting. We also preseted an update on the project to the Safari Club International and California Deer Association.

Outcomes/Impacts:

We analyzed data for survival and determined that our control area 'Cima dome' had higher survival than the other 2 study areas, where we turned water on (midhills) or where water was not provided (New York Mountains). Although survival was high overall in all study areas survival was > 85%. We also determined that deer in the water provided treatments had smaller home ranges and movements than deer in the water limited or Cima area treatments.

Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin – NEV052TB

Investigator Name(s) Last Name and Intitials)

1. Swanson, S.R.

Goals/Objectives/Expected Outputs

Objectives: 1. Inventory land treatment data available from agency offices. 2. Collect and analyze monitoring data from selected current, recent, ongoing, and planned land treatment projects to test

hypotheses. 3. Collect the inventoried data from past projects, enter these data into the database, and analyze to test hypotheses 4. Continue to augment and refine the: table of projects to monitor; monitoring data set; table of monitoring data to acquire; acquired data set; analyses of the data; and the products from the project. Outputs: Fact Sheets, Bulletins, and technically refereed journal articles

Outputs:

General 2012 actions associated with the above included formal and informal presentations concerning the SynMon data base and activities; pre-harvesting coordination with targeted offices and their higher headquarters; travel to field offices and local headquarters; searching for, screening and importing information within targeted offices, over the wire, or here at UNR; building, maintenance and management of file organization and architecture, software and hardware for information inputting, storage and sharing; transmittal of information to collaborators and other interested parties; budgeting/expenditure monitoring; providing periodic reports to collaborators. Geospatial and implementation data were obtained primarily for NW Nevada and NE California wildfire and preventative land treatment event areas. This was done in order to support efforts at identifying and prioritizing candidate sites for 2011 field studies. Including contributions by folks from different agencies and one ranch, we were able to increase the quantity of events in our data base from 6,590 (in January 2011) to 7,210 (by December 2011). Pertinent literature was also fed into the data base. None of the information harvested since the Project's inception has been lost. Backup data-storage (via external hard drive) continued in 2011. For the first time we obtained direct access to the USGS Land Treatment Digitial Library. Information exchange with the USGS's Great Basin Integrated Landscape Monitoring Pilot Project (Boise) continued. Field and related requirements, reviews and/or work plans were developed based on inputs from UNCE, BLM, NDOW, USFWS, and USFS people; one ranching family and the general collaboration group. This led to the following field work being accomplished this year: 1.Quinn River Greenstrip (Humboldt County) Developed a field study protocol and conducted a field protocol class for this joint NDOW/Humbodt-Toiyabe NF initiative. Established, read and shared data from 6 permanent study sites in the project area. 2.Osino, Adobe Hills, and South Fork Humboldt State Park sagebrush planting experiments (Elko County) (Lead Investigator: Kent McAdoo). 3.South Fork Humboldt State Park wheatgrass site conversion project. (Elko County) (Lead Investigator: Kent McAdoo). 4.NW Nevada/NE California Field Studies (Humboldt, Pershing, Washoe, Modoc Counties).(Lead Investigator: John Swanson). Planned, coordinated and implemented field studies on 45 different wildfire and land treatment event sites. Consolidated data and shared with all collaborators. 5.Nevada-wide land treatment studies.(Lead Investigator: Lee Turner). Participated in one-day White Pine County field event designed to help harmonize SynMon field data collection protocol with that of Lee's and the Eastern Nevada Landscape Coalition. Completed the following for the data collected on the 45 NW Nevada/NE California wildfire and land treatment event sites: All data organized and entered onto digital spreadsheet. Compiled data shared with collaborators. Data arcsine-transformed for normalization purposes. Initial regression and correlation runs completed; statistically significant parameter pairs identified.

Outcomes/Impacts:

Collaborators and others used SynMon data base information for several of their efforts, such as development of State and Transition models; production of a film for television; and larger-scale project planning and prioritization efforts. KNPB, 2011. Stewards of the Rangeland. TV film production that I provided some photographs, technical info for. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. 2011 Sharebook. Data base for all SynMon field data collected to date. Has been shared with all project collaborators. Swanson, J. 2011. Field Work Recap and Methods Applied: 2011 Field Data Collection, Quinn River Greenstrip Project. Report submitted to NDOW and Humboldt-Toiyabe NF representatives. Swanson, J. 2011. NW Nevada/NE California Field Studies,

Synergistic Monitoring Project. Submitted to BLM (Winnemucca) and Sheldon National Wildlife Refuge (Lakeview, OR) personnel. Swanson, J. 2011. Special Use Permit Application. Submitted to Sheldon NWR, Lakeview, OR. Swanson, J. 2011. Field Activity Completion Report. Submitted to Sheldon NWR, Lakeview, OR. Swanson, J. 2011. Some SynMon Project Results. Impromptu oral presentation to NRCS, UNR participants, State and Transition Modelling Workshop. Reno, NV. Swanson, J. 2011. SynMon Project Overview. Verbal SynMon overview delivered during coordination meeting with BLM employees, Cedarville, CA. McAdoo, K., J. Swanson, N. Shaw. 2011.Evaluating Strategies for increasing plant diversity in Crested Wheatgrass Seedings: Elko County, NV. Handout for multi-agency field tour. Elko, NV. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. Update: Synergistic Monitoring Project. Oral presentation. SynMon Collaborators Meeting. Reno, NV. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. Update: Synergistic Monitoring Project. Oral presentation for BLM employees. Winnemucca, NV. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. 2010 Field Studies NE Nevada Wyoming Big Sagebrush Event Sites. Oral presentation delivered at Science Delivery Project/Nevada Partners in Conservation Workshop: Vegetation Resilience. Winnemucca, NV. Swanson, J., S. Swanson, K. McAdoo, B. Schultz, G. McCuin. 2011. State and Transition Model Applications: Wildfire and Preventative Land Treatments. Oral presentation at annual meeting of the Nevada Section of SRM. Winnemucca, NV. In December, 2011, Northeastern Nevada Stewardship Group representatives invited me to give an oral presentation at their February 2012 meeting in Elko.

Multi-century streamflow derived from watershed modeling and tree-ring data – NEV052TK

Investigator Name(s) Last Name and Intitials)

1. Saito, L. 2. Biondi, F.

Goals/Objectives/Expected Outputs

Insight on long-term changes of streamflow is critical for addressing implications of global warming on sustainable water management, especially in the semi-arid western USA. A widely used approach for extending the relatively brief instrumental record of streamflow, and obtaining a paleo perspective on recent hydrological changes, is by means of tree-ring records. To date, dendrohydrologists have employed sophisticated regression techniques to extend runoff records, but this empirical approach cannot directly test the influence of watershed factors that alter streamflow independently of climate. We thereby propose a transformative approach for quantifying the effect of watershed topography, vegetation dynamics, natural disturbance (such as wildfire), and land use changes on proxy-augmented streamflow records. This approach can better define uncertainty of paleo reconstructions, since it employs tree-ring records to generate long time series of precipitation (and possibly temperature), which then become inputs to a mechanistic watershed model that calculates streamflow while at the same time determining the influence of landscape changes.

Outputs:

This project involves the development of a mechanistic watershed model that can be used with tree-ring reconstructions of precipitation to generate streamflows for the West Walker River watershed above Coleville, California. Streamflow predictions will be compared to reconstructions directly from tree-ring data. A master's student using a water balance model to provide seasonal estimates of streamflow completed her thesis in 2011. Another graduate student is working with an annual model and will apply the modeling approach to several sites. Presentations on the project were made at the NWRA Annual Conference and at the Universities Council on Water Resources Annual Conference.

Outcomes/Impacts:

Presentations on the project were made at the NWRA Annual Conference and the Universities Council on Water Resources Annual Conference. The project team determined that doing a seasonal model using this approach may not be feasible due to issues with estimating air temperature and precipitation with tree-ring records.

Assessing hydrologic response of plant communities in the Great Basin – NEV052TS

Investigator Name(s) Last Name and Intitials)

1. Saito, L.

Goals/Objectives/Expected Outputs

We hypothesize that alternative stable vegetative states (i.e., cheatgrass dominated sites) will have different hydrologic responses in processes such as infiltration rates, peak discharge rates, and sediment loads than historical Wyoming sagebrush plant communities. We further hypothesize that sites that have been revegetated will be intermediate in hydrologic response to the historical and disturbed site conditions.

Outputs:

We hypothesize that alternative stable vegetative states (i.e., cheatgrass dominated sites) will have different hydrologic responses in processes such as infiltration rates, runoff, peak discharge rates, and sediment loads than historical Wyoming sagebrush plant communities. We further hypothesize that sites that have been revegetated will be intermediate in hydrologic response to the historical and disturbed site conditions. Data from instrumented wildlife water developments (wildlife guzzlers) were collected. Runoff collectors were installed at Smith Creek Ranch. Snow sensors were installed at two guzzler sites.

Outcomes/Impacts:

Information regarding runoff and performance of the runoff collectors was collected and will be used in future project work

WATER AND NITROGEN ACQUISITION BY CHEATGRASS AND NATIVE RANGELAND PLANTS – NEV052UV

Investigator Name(s) Last Name and Intitials)

1. Nowak, R. 2. Leger, E.

Goals/Objectives/Expected Outputs

The overall goal of this project is to further understand the roles of water and nitrogen acquisition in the competitive interactions between cheatgrass and native rangeland species. The underlying rationale for this research is to identify concepts and management strategies to control cheatgrass and facilitate the restoration of native species on Great Basin rangelands. Specifically, we propose to implement mechanistic studies of plant physiological traits that may account for differences in competitive ability between cheatgrass and native species as well as for why changes in soil N availability may cause shifts in these competitive interactions. These studies focus on physiological traits related to the acquisition of water and N resources from the soil: plant water use and N uptake by roots. Specific objectives are: (1) Determine if physiological traits related to the acquisition of water or N consistently account for differences in competitive ability between cheatgrass and native species. (2) Determine if variation in

these physiological traits as soil N availability varies are consistent with changes in the relative competitive ability between cheatgrass and the native species as soil N availability changes. Results from the proposed studies contribute towards the research priority of healthy rangelands for multiple uses in the Great Basin. The proposed research investigates physiological traits that may account for greater competitive ability of native species versus cheatgrass, which in turn can then be exploited to increase the probability of success during restoration efforts. For example, if native species that compete more successfully with cheatgrass have greater N uptake at low N availability, then plant selection and breeding programs for rangeland restoration can target native species or genotypes that exhibit this characteristic. Furthermore, a threshold soil N availability could be established for land managers to use in planning restoration: if certain native species have greater resource acquisition than cheatgrass below a certain level of soil N availability, then managers can target use of those species in areas below the threshold soil N in order to enhance restoration success rates. A third application of results from the planned studies is for maintaining areas that currently are in a good, desirable condition but are in danger of conversion to cheatgrass dominance: land managers can determine if the area has species with the traits we have identified, and then manage the area to maintain those species or implement restoration efforts to reintroduce them. Thus by identifying physiological mechanisms, the results from the proposed studies will have much greater applicability.

Outputs:

During 2011, three experiments were conducted in the greenhouse to examine competition for water and nitrogen by cheatgrass and native grasses. Study 1's primary objective was to determine which characteristics of native grasses are competitive with cheatgrass, with a focus on belowground characteristics related to water and N acquisition. Study 1 was conducted in large 180 liter capacity mesocosms of natives and cheatgrass in monocultures and in competition with each other. The natives used were 5 cultivars of Elymus elymoides. All pots were filled with locally sourced topsoil, neutron probe access tubes were inserted in the pots to monitor water use, and minirhizotron tubes were inserted in the pots to monitor root growth. Plants were started from seed, and experiment will be run for 2 years. Plant growth and leaf photosynthesis of both the native grass and cheatgrass were measured during the first growth cycle. Study 2's primary objective was to determine if native grasses that are present in cheatgrass invaded fields have been selected for competitive traits. Two focal questions for Study 2 are: (1) Is native grass success related to the ability to acquire water and nitrogen in competition with cheatgrass? (2) Is there a consistent set of traits of selected seeds, and if so do we observe directional selection for competitive root traits? Again, Elymus elymoides was the target native species, and we focused on belowground traits related to water and nitrogen acquisition. This study follows on from the initial work done by Beth Leger and her graduate student Sarah Kulpa. In Study 2, small pots were planted with seeds from a bulk seed source (which represents seed from un-selected plants) and with seeds from plants that were survived during an earlier restoration study (presumably had been naturally selected for increased competitive ability with cheatgrass). Seeds of Elymus were planted in pots with and without cheatgrass competition. Plants were harvested each month for 4 months, and above- and belowground biomass were dried and weighed. Plant root systems were washed and imaged with WinRhizo system for root analysis and yielded data on root system length, size, and topography. Study 3 investigated the effects of temperature and nitrogen on biomass production of cheatgrass. Three N treatments (4, 8 and 16 mM N) and 2 growth temperatures were used in Study 3. Overall research questions were: (1) How does Nitrogen affects the photosynthetic response of cheatgrass under controlled conditions? (2) How does nitrogen availability in the field affect maximum assimilation rates in cheatgrass? Ultimately, the focus of this portion of the research is to create a mechanistic assimilation model capable of predicting maximum assimilation rates of cheatgrass in the field, and then apply this

model at a landscape level to identify areas of low maximum seasonal assimilation, which may also indicate areas of low cheatgrass competition that are more likely to be successfully restored.

Outcomes/Impacts:

Results from Study 1 indicate that cheatgrass rapidly used soil water and suppressed growth of all Elymus cultivars. However, Elymus cultivars did vary in their success under competition. The cultivar Shaniko performed the best in monoculture and had the highest tiller production and soil water use. Shaniko also had the highest biomass production both in competition with cheatgrass. We have replanted cheatgrass into the mesocosms, and we expect that Year 2 data may show interesting trends: Elymus in the competition mesocosms have grown and may be able to pre-emptively compete for resources against cheatgrass. Thus, if Elymus plants can initially establish after seeding, then they may be able to reduce the abundance of cheatgrass in subsequent years. Results from Study 2 indicated that unselected plants form the bulk seed source produced higher total root length and biomass than plants from seed that had presumably been naturally selected for greater competitive ability with cheatgrass. Cheatgrass root length was only slightly affected by the presence of native plants and only at the latest harvest date. Results from Study 3 indicate no effect of temperature on leaf assimilation or production, which are results similar to those recently reported for cheatgrass by colleagues at the University of Toronto. However, N treatments significantly increased biomass production, although the relationship between N supply and production was not clear because of the limited number of N treatments. Finally, we have continued to develop our collaborative interactions with scientists in Central Asia to understand why arid land species that are native to one region are "well behaved" in that native region but invasive in the other through joint workshops, faculty visits, and collection of vegetation and climate information from both regions.

Persistence and evolution of native plants in cheatgrass invaded systems – NEV052UW

Investigator Name(s) Last Name and Intitials)

1. Leger, E. 2. Goergen, E. 3. Schierenbeck, K.

Goals/Objectives/Expected Outputs

Plant communities around the world are experiencing exotic species introductions and subsequent invasions, and there is no evidence that either of these processes will subside soon. One dramatic example is the transition of the native Great Basin flora into a cheatgrass (Bromus tectorum) dominated community. An estimated 20,000 km2 is currently invaded, and approximately 45% of land in the Great Basin is at moderate to high risk of being converted to cheatgrass. It is unrealistic to expect that land management can control invasion on this scale. Therefore, the long-term diversity and persistence of native communities experiencing such wide-spread invasion depends on the ability of native species to adapt to the presence of invaders. Native species that persist in invaded systems may possess traits that are the product of simultaneous selection from different factors, including fire, grazing, soil, climate and the local flora, including invasive species. While artificial selection can be used to create plant materials that excel at growing under one or a few conditions, it is difficult to mimic the process of natural multivariate selection, which favors genotypes that can respond to a variety of simultaneous challenges, including rare events such as drought or pest outbreaks. The experiments proposed here can identify which traits are most successful in field conditions. Our first research question addresses surviving native individuals in highly invaded systems: do they possess adaptations that have allowed them to survive in a newly altered environment, or are we observing chance demographic or stochastic remnants? This is an important question for invaded systems because non-random survival (the result of natural selection for adapted genotypes) may indicate that native species have the capacity to evolve more competitive

genotypes, possibly leading to long-term increase and spread of native plants that are adapted to invaded ecosystems. The first goal of this project is to document whether competitive genotypes of four ecologically and economically important native Great Basin plant species have been favored by natural selection in a cheatgrass-invaded landscape (evidenced by a higher frequency of competitive genotypes in invaded populations). The second goal of this research is to determine what ecological circumstances facilitate the most rapid evolutionary change by natives in an invaded landscape. Prior to embarking on these larger-scale research questions, we must first develop the molecular tools necessary to investigate the types of mating system and rates of gene flow in native Great Basin perennial grasses. No variable microsatellite markers have been identified in these species, and the development of these tools is key for verifying the mating system in these species. Microsatellite markers will be used to estimate current gene flow between invaded and uninvaded sites.

Outputs:

A competition experiment with Poa secunda and Bromus tectorum was implemented and completed during this time. Data analysis is ongoing of both the greenhouse study and the microsatellite study, with student completion of the project expected in 2012.

Outcomes/Impacts:

The graduate student on this project was trained in plant ecology methods, as were three additional undergraduate students. The graduate student is learning graphical presentation and analysis of data, and is preparing to present results at a professional conference in 2012.

This study will provide the only demographic data from high latitude for Common Goldeneyes.

Mineral Deficiency or Disease: Wildlife as Indicators for Livestock – NEV052VT

Investigator Name(s) Last Name and Intitials)

1. Stewart, K. 2. Wolff, P. 3. Atkinson, M. 4. Partee, E.

Goals/Objectives/Expected Outputs

Three primary hypotheses have been to the observed symptoms exhibited by mule deer. H1: Symptoms of disease exhibited by mule deer are the result of copper or selenium deficiency, rather than infectious disease. H2: Source of copper deficiency is secondary through high levels of Mo, Zn, Fe or other heavy metals that prevent uptake of copper by the body. H3: Mule deer do not use alfalfa fields exclusively, but use surrounding rangelands for food and water. This preliminary study is to understand source of symptoms exhibited by mule deer on alfalfa hayfields grown for livestock in Nevada, and to determine if the cause is an infectious agent, or primary or secondary mineral deficiency. The long-term goal of this project is to understand ecological and biological factors affecting wildlife and livestock in this region and to determine if the source is toxicity of heavy metals possibly from past mining in the area, some ecosystem level change that may be creating a deficiency in trace minerals in soils, or a pathogen that may be causing deleterious effects on wildlife in the area. This project is a collaborative, multidisciplinary effort, among veterinarians, ecologists, and biologists from Nevada Department of Wildlife, University of Nevada Reno, and Nevada Department of Agriculture to determine the cause of these symptoms in mule deer; and to determine if there is risk for livestock from declining availability of minerals, increasing intake of heavy metals, or emerging infectious disease. Mule deer are an important game species in most Western States and cattle grazing is fundamental component of western rangelands. These symptoms

exhibited by mule deer on agricultural lands have concerned the local farming community, and state wildlife and agricultural agencies for over 10 years. Lack of funding, collaboration, and cohesive approach has hampered previous efforts toward understanding this problem. These observed symptoms in deer may be a result of primary or secondary mineral deficiency, but also may be an indicator of an emerging infectious disease that has not yet been determined. If an infectious disease is the cause of those symptoms, identifying the specific causative agent is important to managing livestock in those areas as well as wildlife. Livestock are grazed near the fields on ranch ground, but deer generally have more extensive ranges than livestock in the area and may become infected with disease or acquire high levels of metals in diet from other areas and return to agricultural fields after early onset of the observed symptoms. Regardless, the outcome of this research is more extensive than a small area of Nevada. If mule deer or other cervid species are more sensitive to deficiencies of trace minerals when they become acute, typically when animals are under stress, such as reproduction, and exhibit symptoms prior to livestock; then cervids may act as indicators of ecosystem level changes that may be overlooked before negative effects become extensive or widespread.

Outputs:

This study is designed to identify the cause of disease symptoms expressed by deer concentrated on alfalfa fields, and if they are the result of an infectious agent, or primary or secondary mineral deficiency. We are also interested in determining residency time and seasonal use of alfalfa fields by mule deer. To assess nutrient levels within this deer population we gathered liver and blood samples from healthy individuals along with opportunistically removing sick animals. We collected 6 liver samples from hunter-killed bucks, and 26 blood samples from live female deer to determine baseline levels of trace minerals and disease prevalence. We also performed a necropsy and collected samples from 2 sick animals to run pathology and toxicology analyses. Vegetation samples have been collected on a monthly basis to identify seasonal changes in nutrient and forage content. Trace mineral analysis has been conducted on 42 plant samples both in or around the alfalfa fields and in the uplands to identify differences in nutrient composition. Water samples were also collected from areas in the uplands and surrounding the fields to assess any potential water contamination issues. Eight water samples were analyzed for presence of dissolved solids and mineral content. During the months of June through October 2011, we conducted bi-weekly counts of deer on the alfalfa fields to determine use as well as identify symptomatic individuals. We began to disseminate information by presenting a poster at the USDA Managed Ecosystems program meeting and at the Annual Wildlife Society meeting.

Outcomes/Impacts:

This past season saw unusually low occurrences of symptomatic individuals and we were able to sample two individuals; a male fawn and adult female. The necropsy identified that the individuals were severely emaciated even though rumen was filled with hay; however no disease agents were identified. This lack of a disease agent coupled with lack of appreciable body fat may support the hypothesis of a nutrient imbalance. Blood serum results indicate that the mule deer populations in Nevada exhibit a wide range of trace mineral levels that are geographically unique. Liver analysis of sick individuals indicates high Iron and Molybdenum levels when compared to reference values. Trace mineral analysis of plant matter identified lower levels of Copper (Cu) in vegetation associated with uplands, when compared to the fields, along with greater variation in Cu levels of sagebrush associated with the uplands. Deer numbers on the alfalfa fields increased slightly from the beginning of summer through fall however remained relatively constant.

Adapted Indian ricegrass for the great basin – NEV052WD

Investigator Name(s) Last Name and Intitials)

1. Leger, E.

Goals/Objectives/Expected Outputs

1. Obtain Indian Ricegrass from diverse sites and ecological areas in the Great Basin. 2. Establish common gardens studies at Central Ferry WA and Reno NV of diverse Indian ricegrass representing Great Basin environmental diversity. 3. Measure a comprehensive set of growth and development factors on Indian ricegrass at both common garden sites. 4. Complete genecology studies linking environmental factors at seed source locations with genetic variation across the landscape to establish seed transfer zones. 5. Make source identified plant material available for utilization through the Western Regional Plant Introduction Station seed repository at the WRPIS and the National Plant Germplasm System.

Outputs:

528 Thurber's needlgrass seedlings were transplanted into a common garden at the University of Nevada, Reno in Fall of 2011. Plants are dormant, and data collection will begin in spring 2012. Plants were initially watered and the plot was weeded, but extremely cold and dry conditions have precluded further plant growth this fall/winter.

Outcomes/Impacts:

A UNR undergraduate student is being trained on plant care and data collection though this project.

Sagebrush monitoring – NEV052WP

Investigator Name(s) Last Name and Intitials)

1. Matocq, M. 2. Sedinger, J.

Goals/Objectives/Expected Outputs

In order to monitor sagebrush ecosystem health in Nevada, we seek to establish 40 sites throughout the state where we will conduct long term monitoring of ecosystem health indicators. The current proposal will a) establish the sites, b) conduct the initial characterization of small mammals at each site, and c) conduct the initial characterization of vegetation structure at each site.

Outputs:

We have sampled the small mammal and vegetation communities at 37 sites for two consecutive years. These sites are located throughout Nevada's sagebrush ecosystem.

Outcomes/Impacts:

We have documented the occurrence of over 16 species of small mammals across the 37 sites sampled. We are currently analyzing these data to identify underlying climatic and vegetation characteristics that are associated with our documented patterns of mammalian biodiversity

Effects of repeated burning on soil nitrogen and cheatgrass biomass and reproduction – NEV052WY

Investigator Name(s) Last Name and Intitials)

1. Leger, E. 2. Johnson, D.

Goals/Objectives/Expected Outputs

Restoration of cheatgrass dominated rangelands depends on controlling cheatgrass while simultaneously providing the conditions necessary for native species establishment. The expansion and eventual dominance of exotic annual grasses and other invaders in semi-arid shrublands often has been attributed to fire and the increase in resource availability resulting from the death of fire intolerant shrubs (Young and Evans 1978, West and York 2002, Evangelista et al. 2004). Soil nutrients are inherently low in these systems, but can increase dramatically following fire, especially available N (NO_3^- and NH_4^+) (Stubbs and Pyke 2005) which can increase up to 12-fold (Blank et al. 1994, 1996). Cheatgrass can take advantage of the high N availability and produce significantly more shoot mass by maintaining higher growth rates than perennial grasses (Monaco et al. 2003). Recent field studies have shown the importance of available inorganic nitrogen in controlling cheatgrass establishment and growth (McLendon and Redente, 1991; Young et al., 1999). Although cheatgrass tends to thrive in a high nitrogen environment, it is inhibited in a low one (McLendon & Redente 1991; Redente et al. 1992; Young & Allen 1997; Young et al. 1999). A novel method to tie up mineral N might be to reduce total N supplies and, therefore, mineral N supplies by repeated burning. It is well documented that nearly all N contained in organic material that is burned is volatilized and lost from the system, potentially causing long-term declines in ecosystem N capital unless the N is replaced by atmospheric deposition, N-fixation, or fertilization (Blair, 1997; Neary et al., 1999; Raison et al., 1985). On the other hand, burning commonly causes short-term increases in soil ammonium levels because of the heat-induced denaturing of soil organic N (Neary et al., 1999; other refs). The pulse of ammonium is often followed by a pulse of nitrate and nitrate leaching once nitrifying bacteria occupy the site again. The short-term pulse of ammonium after fire is thought to be one factor favoring nitrophilic cheatgrass after rangeland fire (Monaco et al. 2003). Over the long-term, however, one would expect that repeated burning without replacement of lost N could cause reductions in soil mineral N levels, at least after the initial post-fire pulse has passed. In 2008, a 5-year study was established north of Winnemucca, Nevada on cheatgrass dominated rangeland to examine the effects of repeated burning and surface litter on soil nutrient dynamics, cheatgrass biomass and reproduction, and establishment of native species. We hypothesized that repeated burning of cheatgrass dominated areas will cause: 1. Significant reductions in soil total and mineral N levels over time, including the magnitudes of the post-fire pulses of ammonium. 2. Significant increases in the C:N ratio of litter, which will further contribute to reductions in soil available N. 3. Significant reductions in cheatgrass biomass and seed production, increasing the potential for successful restoration of native species.

Outputs:

Field data was collected again this year, and will be completed in 2012. Initial results are being analyzed by the graduate student and collaborators on this project, in anticipation of graduation in 2012.

Outcomes/Impacts:

The graduate student has been trained on field methods and data analysis, and is working on developing a greenhouse extension of the project to be started in 2012.

Water and Nitrogen Acquisition by Cheatgrass and Native Rangeland Plants – NEV052XCA

Investigator Name(s) Last Name and Intitials)

1. Nowak, R.S. 2. Leger, E.A.

Goals/Objectives/Expected Outputs

The overall goal of this project is to further understand the roles of water and nitrogen acquisition in the competitive interactions between cheatgrass and native rangeland species. The underlying rationale for this research is to identify concepts and management strategies to control cheatgrass and facilitate the restoration of native species on Great Basin rangelands. Specifically, we propose to implement mechanistic studies of plant physiological traits that may account for differences in competitive ability between cheatgrass and native species as well as for why changes in soil N availability may cause shifts in these competitive interactions. These studies focus on physiological traits related to the acquisition of water and N resources from the soil: plant water use and N uptake by roots. Specific objectives are: (1) Determine if physiological traits related to the acquisition of water or N consistently account for differences in competitive ability between cheatgrass and native species. (2) Determine if variation in these physiological traits as soil N availability varies are consistent with changes in the relative competitive ability between cheatgrass and the native species as soil N availability changes. Results from the proposed studies contribute towards the research priority of healthy rangelands for multiple uses in the Great Basin. The proposed research investigates physiological traits that may account for greater competitive ability of native species versus cheatgrass, which in turn can then be exploited to increase the probability of success during restoration efforts. For example, if native species that compete more successfully with cheatgrass have greater N uptake at low N availability, then plant selection and breeding programs for rangeland restoration can target native species or genotypes that exhibit this characteristic. Furthermore, a threshold soil N availability could be established for land managers to use in planning restoration: if certain native species have greater resource acquisition than cheatgrass below a certain level of soil N availability, then managers can target use of those species in areas below the threshold soil N in order to enhance restoration success rates. A third application of results from the planned studies is for maintaining areas that currently are in a good, desirable condition but are in danger of conversion to cheatgrass dominance: land managers can determine if the area has species with the traits we have identified, and then manage the area to maintain those species or implement restoration efforts to reintroduce them. Thus by identifying physiological mechanisms, the results from the proposed studies will have much greater applicability.

Outputs:

During 2011, three experiments were conducted in the greenhouse to examine competition for water and nitrogen by cheatgrass and native grasses. Study 1's primary objective was to determine which characteristics of native grasses are competitive with cheatgrass, with a focus on belowground characteristics related to water and N acquisition. Study 1 was conducted in large 180 liter capacity mesocosms of natives and cheatgrass in monocultures and in competition with each other. The natives used were 5 cultivars of Elymus elymoides. All pots were filled with locally sourced topsoil, neutron probe access tubes were inserted in the pots to monitor water use, and minirhizotron tubes were inserted in the pots to monitor root growth. Plants were started from seed, and experiment will be run for 2 years. Plant growth and leaf photosynthesis of both the native grass and cheatgrass were measured during the first growth cycle. Study 2's primary objective was to determine if native grasses that are present in cheatgrass invaded fields have been selected for competitive traits. Two focal questions for Study 2 are: (1) Is native grass success related to the ability to acquire water and nitrogen in competition with cheatgrass? (2) Is there a consistent set of traits of selected seeds, and if so do we observe directional

selection for competitive root traits? Again, Elymus elymoides was the target native species, and we focused on belowground traits related to water and nitrogen acquisition. This study follows on from the initial work done by Beth Leger and her graduate student Sarah Kulpa. In Study 2, small pots were planted with seeds from a bulk seed source (which represents seed from un-selected plants) and with seeds from plants that were survived during an earlier restoration study (presumably had been naturally selected for increased competitive ability with cheatgrass). Seeds of Elymus were planted in pots with and without cheatgrass competition. Plants were harvested each month for 4 months, and above- and belowground biomass were dried and weighed. Plant root systems were washed and imaged with WinRhizo system for root analysis and yielded data on root system length, size, and topography. Study 3 investigated the effects of temperature and nitrogen on biomass production of cheatgrass. Three N treatments (4, 8 and 16 mM N) and 2 growth temperatures were used in Study 3. Overall research questions were: (1) How does Nitrogen affects the photosynthetic response of cheatgrass under controlled conditions? (2) How does nitrogen availability in the field affect maximum assimilation rates in cheatgrass? Ultimately, the focus of this portion of the research is to create a mechanistic assimilation model capable of predicting maximum assimilation rates of cheatgrass in the field, and then apply this model at a landscape level to identify areas of low maximum seasonal assimilation, which may also indicate areas of low cheatgrass competition that are more likely to be successfully restored.

Outcomes/Impacts:

Results from Study 1 indicate that cheatgrass rapidly used soil water and suppressed growth of all Elymus cultivars. However, Elymus cultivars did vary in their success under competition. The cultivar Shaniko performed the best in monoculture and had the highest tiller production and soil water use. Shaniko also had the highest biomass production both in competition with cheatgrass. We have replanted cheatgrass into the mesocosms, and we expect that Year 2 data may show interesting trends: Elymus in the competition mesocosms have grown and may be able to pre-emptively compete for resources against cheatgrass. Thus, if Elymus plants can initially establish after seeding, then they may be able to reduce the abundance of cheatgrass in subsequent years. Results from Study 2 indicated that unselected plants form the bulk seed source produced higher total root length and biomass than plants from seed that had presumably been naturally selected for greater competitive ability with cheatgrass. Cheatgrass root length was only slightly affected by the presence of native plants and only at the latest harvest date. Results from Study 3 indicate no effect of temperature on leaf assimilation or production, which are results similar to those recently reported for cheatgrass by colleagues at the University of Toronto. However, N treatments significantly increased biomass production, although the relationship between N supply and production was not clear because of the limited number of N treatments. Finally, we have continued to develop our collaborative interactions with scientists in Central Asia to understand why arid land species that are native to one region are "well behaved" in that native region but invasive in the other through joint workshops, faculty visits, and collection of vegetation and climate information from both regions.

Persistence of native species in cheatgrass invaded systems – NEV052XDA

Investigator Name(s) Last Name and Intitials)

1. Leger, E.A.

Goals/Objectives/Expected Outputs

The existence of remnant populations that can evolve in response to the presence of invaders has important implications for the restoration and management of degraded Great Basin rangelands. This project will both provide basic knowledge about the rate and importance of rapid evolution in invaded

systems, as well as provide direction on how to proceed with management decisions and the development of restoration plant materials for degraded rangelands. Other areas of applied biology have benefited from an evolutionary perspective (such as the response of crop pests to pesticides, e.g. Denholm & Rowland 1992), however this perspective has yet to be applied to the management of rangelands. This proposal is based on a conceptual model of different trajectories that may be followed by native populations following the invasion of highly competitive, exotic species. While invasions of highly competitive species may cause local extinctions of some species, an alternate possibility is that invasions only decrease the relative abundance of species within a community, with some native species persisting at low densities in invaded landscapes (Parker et al. 1999, Seabloom et al. 2006, Stohlgren et al. 1999, 2003). Our first research question addresses these surviving native individuals: do they possess adaptations that have allowed them to survive in a newly altered environment, or are we observing chance demographic or stochastic remnants? This is an important question for invaded systems because non-random survival (the result of natural selection for adapted genotypes) may indicate that native species have the capacity to evolve more competitive genotypes, possibly leading to long-term increase and spread of native plants that are adapted to invaded ecosystems. The first goal of this project is to document whether competitive genotypes of four ecologically and economically important native Great Basin plant species have been favored by natural selection in a cheatgrass-invaded landscape (evidenced by a higher frequency of competitive genotypes in invaded populations). This question is important for land managers because very different management actions are needed when adaptation occurs than when it does not. The second goal of this research is to determine what ecological circumstances facilitate the most rapid evolutionary change by natives in an invaded landscape). There are a variety of expectations about what conditions are likely to foster or hinder rapid evolutionary change. Prior to embarking on these larger-scale research questions, we must first develop the molecular tools necessary to investigate the types of mating system and rates of gene flow in native Great Basin perennial grasses. No variable microsatellite markers have been identified in these species, and the development of these tools is key for verifying the mating system in these species. During the course of this proposal, microsatellite markers will be used to estimate current gene flow between invaded and uninvaded sites.

Outputs:

Field and greenhouse work was completed during this reporting period, and data analysis is ongoing. The graduate student on the project is making progress towards graduation, expected in 2012.

Outcomes/Impacts:

The graduate student has learned lab skills (microsatellite development) and greenhouse skills related to native plant ecology and restoration. Results of this project will be presented by the graduate student in 2012.

Monitoring the effects of grazing on Orcuttia Tenuis on the Modoc Plateau – NEV052XG

Investigator Name(s) Last Name and Intitials)

1. Weisberg, P.

Goals/Objectives/Expected Outputs

To better understand factors that influence O.tenuis on the Modoc Plateau, we propose to expand our ongoing study of grazing effects to include an evaluation of hydrology, using both field-based and remote sensing methods. The objectives of this additional work are to answer the following questions: 1)How does grazing influence duration and timing of inundation at vernal pools? 2)How do duration and timing of

inundation at vernal pools vary across different years according to variation in climate? 3)How do duration and timing of inundation affect O. tenuis density and vigor? 4)How do duration and timing of inundation affect species richness and composition of vernal pool plant communities? 5)Can management actions improve or restore hydrologic function to promote the recovery of O. tenuis ?

Outputs:

In summer 2011, 20 monitoring sites were revisited and sampled including 1 site on BLM (ungrazed), 7 sites on Lassen NF (3 ungrazed and 4 grazed), and 12 sites on Modoc NF (10 O. tenuis sites with paired grazed and ungrazed plots, one Tuctoria greenei site with paired plots, and 1 T. greenei ungrazed site). Vegetation sampling utilized the same methodology as in 2009 and 2010 (reported in CRIS 2010). In summer 2011, additional data were collected at 2 vernal pools on the LNF to quantify hydroperiod and community structure at the ecosystem level. These sites were NE Coyote Spring (grazed) and Adobe North (ungrazed) vernal pools. During winter 2010, digital cameras (Moultrie Game Spy I-65) with solar panels were mounted to a tree surrounding each of the vernal pools and set on time-lapse photography to take a photograph of the pool 6 times per day. Two stage gauges (made from PVC with colored 2 cm segments) were placed in each pool within sight of the cameras to record daily water depth and inundation period at two different locations within each pool. Temperature data loggers (Thermachron iButtons) were secured to the base of the stage gauges to record water temperature at two-hour intervals to verify the stage gauges were under water for the periods of inundation seen on the photographs (when data logger temperature was consistent with air temperature, the ground was no longer inundated). The sites were monitored approximately once every 2 months to download data, replace batteries, and check for vandalism to the equipment. During July and August 2011, perpendicular and parallel transects were established at every 25 meters in a gridded design across both vernal pools. The 25 meter grids were established pre-field sampling in ArcGIS 9.3 by utilizing XTools Pro 8.0; the other transects were established in-situ during sampling. Along each transect, a 1-m2 plot was sampled at each intersection of the grid (located within and immediately surrounding the vernal pool shapefile). A 1-m2 quadrat was randomly placed (random numbers generator in Microsoft Excel) in one of four ordinal directions: NE, NW, SW, and SE. In each 1-m2 plot, data were collected as described above for the O. tenuis microplots, plus additional hydrological data (elevation) were collected.

Outcomes/Impacts:

Study results suggest that changes in VP hydrologic regimes could play a significant role in the continued survival of O. tenuis and other endemic VP plants.Preliminary results from our seed bank investigations and species distribution and inundation suggest suitable habitat is available for specialist vernal pool species, but is not currently being utilized due to lack of seed availability; therefore on-site barriers may limit seed dispersal. Potential restoration activities include removing man-made berms, gullies, and dams to restore natural hydrologic patterns, facilitating seed dispersal, and maintaining the range of conditions needed to support diverse VP plant communities. Future research will examine potential climate change effects on VP inundation period and implications for northern California VP plants, including opportunities for hydrologic restoration to mitigate negative effects on native species diversity. Meredith Gosejohan presented: 1. A poster at Northern California Botanists Symposium in Chico, CA in January 2011. 2. A poster at California Native Plant Society Conservation Conference in San Diego, CA in January 2012.

Learning together: great basin science delivery – NEV052XJ

Investigator Name(s) Last Name and Intitials)

1. Leger, E.

Goals/Objectives/Expected Outputs

Improving the effectiveness of fire, fuels, and post-fire management in the fire-ruled sagebrush biome is essential to protecting Great Basin resources. Fire and fuels-related research in the Great Basin is providing much of the information needed to improve management (e.g., http://www.firescience.gov). However, the penetration of this information to public land managers and its application on the ground is uneven and often limited. Fire frequency and size are increasing and the invasive species are gaining ground. Participants of the 2006 "Workshop on Collaborative Research and Management in the Great Basin," the 2008 "Wildfire and Invasive Plants in American Deserts Conference," and the 111 land managers who participated in the science needs assessment conducted for this project provided direction about the kinds of science information they need and delivery mechanisms they are more inclined to use. The goals of this project are to: Empower Great Basin land managers to identify their technical needs with respect to fuels, fire, and post-fire vegetation Develop information and technical tools to meet the these needs Provide the needed information and tools through venues most preferred by field staff, field office managers, and higher administrative levels. The Science Delivery Project proposes to meet these goals through: 1.Ongoing needs assessments 2.Information syntheses 3.Online training 4.Web-based clearinghouse of information 5.Network of experts from management agencies and research agencies 6.Field workshops 7.Evaluation.

Outputs:

This project received implementation funding in September of 2010, hence 2011 was this project's first full year of implementation. Significant activities during this period included development of the fall/winter webinar series, our first two-day fire and fuels workshop, our first field day, development of a 26-member interagency Great Basin Restoration Cadre, development of our website, and a transition of our list serve from a generic email format to the professional email service, Mail Chimp. We also hired a synthesis writer in the fall to write two syntheses for us, one on vegetation treatments and one on soils, which will be published in the summer/fall of 2012.

Outcomes/Impacts:

In 2011 we hosted seven webinars with a total of 450 attendees and 334 recorded webinar views. We had 85 people participate in our first workshop and field tour. Our Restoration Cadre has produced two blog discussions for the website. The number of unique visitors to the website has nearly doubled from 124 visitors in September of 2010 to 451 visitors in September of 2011. We have gained three new partners in the Great Basin Landscape Conservation Cooperative, the Association for Fire Ecology, and the National Wildfire Coordinating Group's Fire Behavior Subcommittee. We continue to receive positive feedback about our efforts from evaluations as well as unsolicited emails and phone calls from members of the Great Basin management and research community.

Improving Range Cattle Health Through DNA Paternity Identification – NEV05340A

Investigator Name(s) Last Name and Intitials)

1. Gomez-Raya, L. 2. Perryman, B. 3. Rauw, W. 4. Bruce, B. 5. Wuliji, T. 6. Thain, D.

Goals/Objectives/Expected Outputs

The authors have developed an accurate method to determine paternity in free range beef cattle (Gomez-Raya et al., 2008). The goals of this current project proposal are aimed at developing strategies that will increase the efficiency of DNA paternity testing programs by decreasing the time required to obtain results, analyzing test accuracy and decreasing the costs associated with DNA testing. The results of this research will greatly aid in the development of a DNA paternity testing program at UNR which would be available for use by Nevada cattle producers for the lowest possible price. In order to accomplish the goals of this research we plan to complete the following research aims: 1. To evaluate the economic value of an optimized DNA paternity testing program using six Nevada beef cattle ranches which operate in a free range setting. 2. To investigate the benefit-cost ratios of using sire-dam-calf trios versus sire-calf duos in DNA paternity testing. 3. To investigate the ability to reduce genotyping costs using a sequential paternity rejection strategy. 4. To investigate the increased benefits of using DNA parentage information in heifer selection. 5. To develop methods to incorporate animal disease surveillance with a paternity testing program to allow for increased traceability of livestock carriers and reducing the incidence of disease outbreaks. Expected output is an economically efficient method for DNA paternity testing in free range beef cattle.

Outputs:

Ear notches samples were taken in 2011 at two free range beef cattle operations to estimate calves' paternity. We used a total of 24 microsatellites and the software CERVUS to assign paternities. We are currently using the results to compare the use of different microsatellite panels and individual microsatellites on the economic profitability of DNA paternity programs.

Outcomes/Impacts:

Preliminary data was presented to producers at the annual Cattlemen's Update program outlining characteristics of successful sires.

Bighorn Sheep Health – NEV05352

Investigator Name(s) Last Name and Intitials)

1. Thain, D. 2. Rink, A. 3. Atkinson, M. 4. Gomez-Raya, L. 5. Teglas, M. 6. Wuliji, T. 7. Bruce, B. 8. Perryman, B.

Goals/Objectives/Expected Outputs

1. Identify baseline health data for Bighorn Sheep (BHS) in Nevada. This will include normal baseline blood chemistry, serology, upper respiratory microorganism in normal BHS, trace mineral levels, internal and external parasites, and overall body condition as well as abnormal health data as determined by sampling of live or dead (natural mortality or hunter killed) BHS. 2. Determine the genetic relationship between populations of BHS in Nevada, both native and reintroduced. 3. Develop a database to store all data collected.

Outputs:

We have continued our collaboration with the Nevada Department of Wildlife (NDOW). We monitored three subpopulations of bighorn sheep located in the Sand Springs, Desatoya, and Clan Alpine Mountain Ranges. Two of the subpopulations (Desatoya and Clan Alpine) appear to be in better health than the one that had a recent die-off (Sand Springs). The primary study objective is to assess the overall health of each subpopulation and to understand what factor(s) were driving this decline. Forage samples from 4 seasons have been collected and analysis is ongoing. We collected over 200 fecal samples for parasite identification and genetic analysis and analysis for forage consumption.

Outcomes/Impacts:

Bighorn sheep are an important big game species in the state of Nevada and several populations continue to decline across America. When changes occur to local populations within the state, it is essential to investigate impacts in order to manage the subpopulation and aid in the recovery.

Rehabilitation of a salt-desert shrub community:Herbaceous response to shrub removal and establishment of forage kochia and other plant species – NEV05356

Investigator Name(s) Last Name and Intitials)

1. Stringham, T.

Goals/Objectives/Expected Outputs

The goals of this project are to determine the potential of shrub removal, reduction of annual grass after disturbance, and seeding of forage kochia and grasses for rehabilitation of Great Basin salt-desert shrub communities. Immigrant forage kochia, experimental forage kochia germplasm, and selected grasses (crested and Siberian wheatgrass, intermediate and tall wheatgrass, Russian wildrye, Basin wildrye, creeping wildrye, wildrye hybrids, salt grass, and alkali sacaton) will be compared for their ability to establish, persist, and act as green fuel breaks. The objectives of this project are to determine: 1. The influence of shrub removal on diversity and abundance of herbaceous species and soil nutrient and water availability. 2. The effectiveness of Pseudomonas fluorescens strain D7 (Pf D7) and imazapic (Plateau)applications to limit annual grass invasion following shrub removal. 3. The establishment and persistence of forage kochia and several grasses. 4. If forage kochia will expand beyond the seeded area. 5. Plant traits that enhance seedling establishment and persistence, and the most efficient seeding protocol for the salt desert ecosystem. Tentative Schedule: FY 2011: Shrub removal study: Plot layout, collect baseline vegetation data, remove shrubs and apply imazapic and Pf D7. Build fence around both locations. Seeding Study: Install weather stations. Start space-plants (3-4,000 specimens) in greenhouse. Build fence around both locations. Conduct site preparation (roto-tilling, herbicide application). Plant space-plants and seeded trials. FY 2012: Shrub removal study: Collect vegetation and soil data. Seeding Study: Take seedling establishment data on seeded trials at both sites. Take forage samples for moisture content. FY 2013: Shrub removal study: Collect vegetation and soil data. Assess frequency of future data collection. Analyze data and begin working on publications. Seeding Study: Collect plant persistence data, forage and seed yield data on seeded and spaced-plant trials. Conduct seed threshing and deep seeding evaluation. Conduct forage quality. FY 2014: Shrub removal study: Submit manuscripts for peer-reviewed publication. Seeding Study: Collect plant persistence data, forage and seed yield data on seeded and spaced-plant trials. Conduct seed threshing and deep seeding evaluation on selected grasses. Conduct forage quality. Begin writing manuscripts for submission to a peer-reviewed journal.

Outputs:

Seeding study: During 2011, the seeding trials were implemented. Prior to seeding, the study plots were

treated with the herbicides glyphosate and 2,4-D for control of annual weeds. Herbicide treatment was applied by Charlie Clements with the USDA-ARS in Reno, Nevada. Plant species used in the seeding experiment were: Achnatherum thurberianum, Agropyron desertorum, Artemisia tridentata ssp. wyomingensis, Elymus elymoides, and Achnatherum hymenoides. Seeding treatments included: 1)Seeds coated with diatomaceous earth and agglomerated by species (~10 seeds/agglomerate); 2)seeds uncoated, seeded in clumps, 3)seeds uncoated, single seed planting with ~24 seeds/foot (did not include sagebrush); and 4)seeds coated, single seed planting with ~24 seeds/foot (did not include sagebrush). Seed coating was conducted by one of our collaborators, Dr. Matthew Madsen, at the USDA-ARS in Burns, Oregon. Five plots with treatments randomly assigned to each row were hand sown in November 2011. Data collection on seedling emergence, establishment, and biomass will be collected in 2012. Shrub removal study: data collection and data analysis are currently in progress.

Outcomes/Impacts:

This project is still in progress and no results are available at this time.

Graduate Student Exchange Program with Turkmenistan – NEV053CH

Investigator Name(s) Last Name and Intitials)

1. Perryman, B.

Goals/Objectives/Expected Outputs

The specific objectives of the project are: 1) Expand the scope of expertise available to address issues of natural resource management within the Great Basin by accessing expertise from a similar ecological zone in Turkmenistan and greater Central Asia; 2) Enrich the experience of graduate students in both Nevada and Turkmenistan through a student exchange program where CABNR and UNR serve as the hosting institutions; 3) Develop a research program that will lead to funding from international development sources; 4) Strengthen and build the international program activities of CABNR.

Outputs:

Two grazing exclosure sites have been completed. One is located in the Kara Khum desert NW of Ashgabat and the other near Dasoguz and the Uzbek border. One additional exclosure is planned. The PI traveled to Turkmenistan by invitation in November 2011 to oversee the project and to provide a presentation for an ecological conference in Ashgabat. The PI plans to return in the spring for data collection.

Outcomes/Impacts:

Turkman scientists are learning how their rangelands are being used by traditional nomadic animal agriculture communities, and how to determine the impacts resulting from past and current land use practices.

Sagebrush Demography and Climatic Controls in Semi-arid Ecosystems of Nevada – NEV053CJ

Investigator Name(s) Last Name and Intitials)

1. Perryman, B.L. 2. Bruce, L.B.

Goals/Objectives/Expected Outputs

Shrub establishment in semi-arid areas is episodic in natural populations. The identification of when

recruitment pulses naturally occur can assist land managers in ecosystem rehabilitation/reclamation and restoration activities. Specific objectives include: 1) Determine sagebrush seedling (cohort) origin years from shrub-ring analysis of individuals in selected stands in different geographic regions across Nevada, for five species/subspecies of sagebrush; and 2) Relate the cohort/stand origin years to seasonal and/or monthly temperature and precipitation patterns of years before, during, and after years of origin, using principle component analysis and logistic regression.

Outputs:

All work was completed and documented in September 2011. The most interesting finding of this research was the significance of global climatic patterns. Monthly Pacific Decadal Oscillation (PDO) index variables were correlated with seedling recruitment in all species studied. This relationship was significant (α=.05) for low sagebrush at and Wyoming big sagebrush at each study site. July PDO was the most significant variable for low sagebrush at the Willow Creek Ridge site (R^2=0.1058, $P<0.0026$) and the Montana Mountain Site (R^2=0.2188, $P<0.0023$). April PDO was the most significant variable for Wyoming big sagebrush at the Antelope Valley site (R^2= 0.1459, $P<0.0071$) and the Santa Rosa site (R^2= 0.1435, $P<0.0248$). In general the shift from cool to warm phase of the PDO corresponded with increased sagebrush cohort recruitment. These results suggest that timing restoration efforts with the larger climatic environment may result in increased success.

Outcomes/Impacts:

Project conclusions will provide restoration/rehabilitation practitioners with more detailed requirements for sagebrush establishment in the Great Basin, leading to more efficient seeding activities.

State-and-transition model development for Nevada upland and riparian ecological sites in major land resources – NEV053CY

Investigator Name(s) Last Name and Intitials)

1. Stringham, T. 2. Freese, E.

Goals/Objectives/Expected Outputs

The goal of this project is to lay the foundation for development of STMs for all MLRAs located within the state of Nevada. To facilitate this goal, UNR and NRCS have chosen one MLRA (24) as a test platform for determining and efficient methodology for writing quality STMs. 1. Evaluate the available personnel from outside UNR for area expertise and willingness to participate in state-and-transition model development. 2. Evaluate models from neighboring states for applicability to Nevada. 3. Evaluate individual ecological sites within MLRA 24 for similarity in soils, precipitation and plant community. Evaluate response to disturbance and develop response groups of ecological sites. 4. Produce STMs for the modal ecological site for each response group.

Outputs:

Conceptual state-and-transition models (STMs) for the upland ecological sites within the Nevada component of the Major Land Resource Area 24 have been developed, peer-reviewed and the final report provided to the USDA, Natural Resource Conservation Service. The goal of this project was to lay the foundation for development of STMs for all MLRAs located within the state of Nevada. To facilitate this goal, UNR and NRCS have chosen one MLRA (24) as a test platform for determining and efficient methodology for writing quality STMs. This methodology has proven to be robust and contracts for the development of STMs for MLRA 25, 23, 28a and 28b are funded and work is underway.

Outcomes/Impacts:

The final report for State-and-Transition Models for MLRA 24 was delivered to the Nevada state office of the Natural Resource Conservation Service in June 2011. A workshop sponsored by the Nevada Society for Range Management was held in Winnemucca, NV in December 2011 with over 60 people participating. The majority of particpants were from the BLM and NRCS representing the organizations primarily responsible for the development of STMs and their application to management of the Great Basin rangelands. Additional impacts include BLM and NRCS funding of continued STM development for MLRA 23, 25, 28a and 28b.

Quantifying environmental benefits from implementing rangeland and conservation practices within the great basin – NEV053DC

Investigator Name(s) Last Name and Intitials)

1. Stringham, T.

Goals/Objectives/Expected Outputs

The University of Nevada at Reno, under the direction of Dr. Tamzen Stringham, is undertaking a cooperative project with the Agricultural Research Service and the Natural Resources Conservation Service to document the status of knowledge regarding the effect of conservation practices applied to rangelands within the Great Basin. The primary purpose is to construct the scientific foundation for the Conservation Effects Assessment Project (CEAP) by documenting what is known and what is not known about the environmental effects of conservation practices on rangelands hydrologic and plant growth processes. The work will focus on the effects of conservation practices applied to rangelands on the following environmental outcomes: water availability, water quality, soil quality, habitat, forage availability, and fuel reductions.

Outputs:

Rainfall simulation was completed on over 40 pinyon or juniper trees with 160 storms having been applied. Data analsysis to-date suggest over 75% of the variation in throughfall plus stemflow data can be explained by tree canopy area and storm size. Data analysis is on going. Twenty eight small plot rainfall simulations were conducted on four cover types: low vegetation, high vegetation, low vegetation with treatment slash and high vegetation with treatment slash. Preliminary results suggest both vegetation cover amount and slash are significant in reducing the amount of sediment production from pinyon-juniper encroached rangelands. Data analysis is ongoing. Two field tours of the Porter Canyon Watershed were held in 2011 with over 70 individuals participating. USDA NRCS, BLM, USFS, USFWS, USGS, Nevada Dept. of Wildlife, Nevada Wilderness Society, Senator Reid's congressional staff, private individuals and businesses along with private land managers attended.

Outcomes/Impacts:

Two poster presentation on preliminary results were given at the University of Nevada, Reno Agricultural Experiment Station Field Day in September 2011. Additionally, an invited presentation was given at the Great Basin Consortium First Annual Conference and three professional papers will be presented at the Society for Range Management annual meeting in 2012. The rainfall interception results were presented to over 100 livestock producers on the recent UNR Cattlemen's Update tour.

Cooperative restoration of wildfire impacted rangelands in Kings River Valley, NV – NEV053DD

Investigator Name(s) Last Name and Intitials)

1. Stringham, T.

Goals/Objectives/Expected Outputs

Project Objectives: To determine: 1. The impact of grader installed fuel breaks on soil bulk density, infiltration, residual seed bank, and establishment of native and non-native seeded plant species. 2. The impact if caterpillar installed fuel breaks on soil bulk density, infiltration, residual seed bank, and establishment of native and non-native seeded plant species. 3. The impact of seeding method (no-till drill vs. disk and drill) on establishment of seeded plant species within grader and caterpillar installed fuel breaks.

Outputs:

Seeding study: During 2011, the seeding trials were implemented. Prior to seeding, the study plots were treated with the herbicides glyphosate and 2,4-D for control of annual weeds. Herbicide treatment was applied by Charlie Clements with the USDA-ARS in Reno, Nevada. Plant species used in the seeding experiment were: Achnatherum thurberianum, Agropyron desertorum, Artemisia tridentata ssp. wyomingensis, Elymus elymoides, and Achnatherum hymenoides. Seeding treatments included: 1)Seeds coated with diatomaceous earth and agglomerated by species (~10 seeds/agglomerate); 2)seeds uncoated, seeded in clumps, 3)seeds uncoated, single seed planting with ~24 seeds/foot (did not include sagebrush); and 4)seeds coated, single seed planting with ~24 seeds/foot (did not include sagebrush). Seed coating was conducted by one of our collaborators, Dr. Matthew Madsen, at the USDA-ARS in Burns, Oregon. Five plots with treatments randomly assigned to each row were hand sown in November 2011. Data collection on seedling emergence, establishment, and biomass will be collected in 2012. Shrub removal study: data collection and data analysis are currently in progress. Project extended to June 30,2012 with additional funding requested.

Outcomes/Impacts:

Project is ongoing and results have not yet been determined.

A Field Guide to Nevada Shrubs – NEV053DF

Investigator Name(s) Last Name and Intitials)

1. Perryman, B.

Goals/Objectives/Expected Outputs

In order for a taxonomic field guide to be widely adopted, it must have 3 characteristics: 1) It must have accuracy and precision as an identification tool; 2) It must be packaged in a usable, convenient format; and 3) The contents must be easily applied to field specimens, that is, it must be easy to use. Taxonomic keys must have the ability to correctly delineate individual shrub species based on morphological and ecological characteristics and the ability for a particular delineation to be repeated by many different types of users in order to instill validity and ensure confidence among potential users. Field guides, of necessity, should not be too comprehensive. Reference guides that consist of several hundred or a thousand pages are inappropriate as a field guide and of little use to field users. Taxonomic references often consist of only technical, dichotomous descriptions of morphological characteristics supplemented by a limited

group of representative pencil drawings. The overall objective of this project is to develop a field guide for shrubs of Nevada that is accurate and precise, is packaged in a usable, convenient format, and is simple to use.The output will be a taxonomic reference book entitled: A Field Guide to Nevada Shrubs as a companion reference to the very successful work, A Field Guide to Nevada Grasses (2007).

Outputs:

Field and writing work continued in spring and summer 2011. Taxonomic keys have been developed and written for 126 shrub species that have potential to be included in the guide. Photographs of 85 shrub species (both northern Nevada and Mojave area) have also been collected. Follow up photography is planned for the growing season of 2012. Construction of ecological keys will begin in February 2012.

Outcomes/Impacts:

Initial planning included micro-photography approaches to presenting plant parts. After initial forays into micro-photography, new techniques were developed to capture only diagnostic characteristics in field setting photographs.Since several families of plants are included, diagnostic features are variable. Photographs include different plant parts for different species.

Impact Of Contraceptive Treatment On Fertility And Behavior Of Feral Horses 5-7 Years Post-Treatment – NEV053DKA

Investigator Name(s) Last Name and Intitials)

1. Thain, D.S. 2. Gray, M. 3. Cameron, E. 4. Miller, L.

Goals/Objectives/Expected Outputs

This will be the first study to investigate long term efficacy and behavioral side effects in feral horses treated with contraception and a continued collaboration with experts in the fields of equine behavior and contraception. We aim to understand how long these contraceptive formulations last and when females return to fertility. Our long term goals are to understand how to better manage feral horse populations that minimizes behavioral or physiological side effects, which will most likely produce a shift in management away from gathers and towards contraception (see Figure 1). Our expected results should increase the use and research of contraceptive technologies. Ultimately, we hope to demonstrate the effectiveness and safety of long term contraceptive use in order to shift public perspectives towards a more positive view of using contraception as a management tool in feral horses and other overabundant species. Better management will result in lower costs, while maximizing horse and rangeland health, which benefits other wildlife and agricultural practices.

Outputs:

This is the 2nd year of funding for the project, but this research is a continuation of NEV053BS "Long term contraception in feral horse: Efficacy, safety and behavior". We monitored horses on a weekly basis for fertility status and band fidelity. We also recorded body condition and collected fecal samples. Data was collected and summarized for the year.

Outcomes/Impacts:

A description of behavioral data collection was discussed in ANSC 455 Domestic Animal Behavior and Welfare

Factors Influencing Desert Bighorn Sheep Health And Population Persistence – NEV053DL

Investigator Name(s) Last Name and Intitials)

1. Thain, D. 2. Gray, M. 3. Matocq, M. 4. Stringham, T. 5. Shenkoru, T.

Goals/Objectives/Expected Outputs

Goals and Objectives: The proposed research is the first phase of a long-term monitoring program designed to understand factors influencing health of bighorn sheep populations. Our two main objectives are to understand 1) what factors influence health and persistence of bighorn sheep populations and 2) how does the presence of domestic livestock impact forage quality and availability for desert bighorn sheep populations. The three major causes of mortality have been identified as nutritional deficiency, disease, and low genetic variation. In addition, stress levels will also be measured. To investigate the role that each plays, we will examine each factor simultaneously by monitoring each population for the next three years. We will also monitor the presence of cattle in each range. This research will contribute to a long-term monitoring program that will determine which populations are healthy and which individuals would make the best candidates for translocation. We will also be able to provide management prescriptions to enhance population health and longevity of all desert bighorn sheep populations. Expected Outputs: Our project will include several undergraduate researchers during the summer months to educate them on field and laboratory techniques. The Department of Animal Biotechnology will integrate the technology and results from this study into lecture, laboratory, and field courses, such as courses in Veterinary Medicine (e.g., VM475/675 Diseases of Domestic Animals), and courses in the Range Animal Production Option of the Animal Science curriculum (e.g., ASC413/613 Range-Livestock Interaction). Our state contains several desert bighorn sheep populations, and our research will enhance management of populations and increase sheep and rangeland health. The results will also provide a better understanding of any interactions that occur between bighorn sheep and domestic livestock. These results from this study will benefits local ranchers, hunters, and wildlife enthusiasts. Our research will enhance the understanding of bighorn sheep health and livestock interactions and can be used for future management. It will also lead to a better population monitoring protocols, identification of factors that impact bighorn sheep health, and improve translocation efforts.

Outputs:

We have continued our collaboration with the Nevada Department of Wildlife (NDOW). We monitored three subpopulations of bighorn sheep located in the Sand Springs, Desatoya, and Clan Alpine Mountain Ranges. Two of the subpopulations (Desatoya and Clan Alpine) appear to be in better health than the one that had a recent die-off (Sand Springs). The primary study objective is to assess the overall health of each subpopulation and to understand what factor(s) were driving this decline. Forage samples from 4 seasons have been collected and analysis is ongoing. We collected over 200 fecal samples for parasite identification and genetic analysis and analysis for forage consumption.

Outcomes/Impacts:

No outcomes or input to report at this time.

Factors Influencing Desert Bighorn Sheep Health and Population Persistence – NEV053DLA

Investigator Name(s) Last Name and Intitials)

1. Thain, D.S. 2. Gray, M. 3. Matocq, M. 4. Stringham, T. 5. Shenkoru, T.

Goals/Objectives/Expected Outputs

The proposed research is the first phase of a long-term monitoring program designed to understand factors influencing health of bighorn sheep populations. Our two main objectives are to understand 1) what factors influence health and persistence of bighorn sheep populations and 2) how does the presence of domestic livestock impact forage quality and availability for desert bighorn sheep populations. The three major causes of mortality have been identified as nutritional deficiency, disease, and low genetic variation. In addition, stress levels will also be measured. To investigate the role that each plays, we will examine each factor simultaneously by monitoring each population for the next three years. We will also monitor the presence of cattle in each range. This research will contribute to a long-term monitoring program that will determine which populations are healthy and which individuals would make the best candidates for translocation (Figure 1). We will also be able to provide management prescriptions will enhance population health and longevity of all desert bighorn sheep populations.

Outputs:

We have continued our collaboration with the Nevada Department of Wildlife (NDOW). We monitored three subpopulations of bighorn sheep located in the Sand Springs, Desatoya, and Clan Alpine Mountain Ranges. Two of the subpopulations (Desatoya and Clan Alpine) appear to be in better health than the one that had a recent die-off (Sand Springs). The primary study objective is to assess the overall health of each subpopulation and to understand what factor(s) were driving this decline. Forage samples from 4 seasons have been collected and analysis is ongoing. We collected over 200 fecal samples for parasite identification and genetic analysis and analysis for forage consumption.

Outcomes/Impacts:

Bighorn sheep are an important big game species in the state of Nevada and several populations continue to decline across America. When changes occur to local populations within the state, it is essential to investigate impacts in order to manage the subpopulation and aid in the recovery.

ESM Department University of Wyoming Accomplishments

May 3, 2012

Annual Report to UW – Check list since July 2011.

- Largest undergraduate program in rangeland ecology and management
- Undergraduate degree is accredited by the Society for Range Management
- 50-60 graduate students
- About $9 million in active external grants and contracts, growing by about $1 million per year
- Faculty are on numerous regional, national, and international committees

- Dr. Thomas Thurow was recognized with College of Agriculture and Natural Resources Outstanding Educator Award, the John P. Ellbogen Meritorious Classroom Teaching Award, and the Range Science Education Council/Society for Range Management Outstanding Undergraduate Teacher Award.
- Dr. Pete Stahl was recognized with the UW Faculty Commitment to Internationalization Award
- Amanda Bryant (PhD entomology student) was recognized with the UW U.S. Graduate Student Internationalization Award
- Several graduate students have won presentation awards at professional society meetings
- Undergraduate Rangeland Ecology and Watershed Management students compete at regional and international competitions. Were awarded the Trail Boss Top University award by the Society for Range Management, Ben Jones won the Undergraduate Extemporaneous Speaking Contest, Sage Askin won the Undergraduate Range Management Exam with the team placing 2nd, 2nd in the Rangeland Cup Team Award (critical thinking and presentation), 3rd in the Chapter Display Contest. Travis Decker was elected Vice President of the SRM Student Conclave.
- Alex Latchininsky, Scott Schell, and Douglas Smith among others, were awarded the International Integrated Pest Management Award of Excellence for their Rangeland Grasshopper IPM Program.
- Two of the seven outstanding students recognized by Gamma Sigma Delta were rangeland ecology and watershed management majors (Shane Bell – Outstanding Male Freshman; Amanda O'Donnell – Outstanding Sophomore).
- Megan Taylor, MS student in rangeland ecology and watershed management, won the Society for Range Management Graduate Student Oral Paper Competition.
- Janet Chen, PhD in PiE (REWM), was selected for the Outstanding Student Paper Award by the Biogeosciences Section of the American Geophysical Union.
- Caley Salava, PhD in PiE (Soil Science), placed 3rd in the poster competition at the Front Range Ecology Symposium.
- Victoria Zero, MS student in rangeland ecology and watershed management, was awarded a National Science Foundation Graduate Fellowship.
- Renee Gebault King, PhD student in soil science, was awarded a North American Colleges and Teachers of Agriculture Outstanding Graduate Teaching Assistant Award.
- Cindy Wood, Accounting Associate Senior (now Accountant), was recognized with the E.G. Meyer Family Staff Award by the Staff Senate.

Utah State University

Annual Report

Students: Majoring in Rangeland Resources only

Fall 2007 – 23 students
Fall 2008 – 25 students
Fall 2009 – 29 students
Fall 2010 – 21 students
Fall 2011 ~ 23 Students
Fall 2012 – 24 Students

Meetings:

RESTORING THE WEST CONFERENCE 2011 - Sustaining Forests, Woodlands, and Communities Through Biomass Use, Utah State University October 18 & 19, 2011,
Eccles Conference Center, Logan, Utah.
The 2011 Restoring the West conference examined how woody biomass harvest can facilitate land restoration projects while supplying much-needed fuel for renewable energy. Talks focused on how biomass harvest can occur in ways that improve the ecological and financial feasibility of restoration projects. The conference had a dual focus on the ecological effects of woody biomass harvest, and the technology of woody biomass harvest and use.

Faculty:
Gene Schupp, Doug Ramsey, Peter Adler, Kari Veblen, Chris Call, Fee Busby, Roger Banner, Beth Burritt, Ron Ryel, Juan Villalaba, Mark Brunson, Terry Messmer
9 Faculty, 3 Extension
47 M.S. and 32 Ph.D. Grads in Wildland Resources Dept., 21 M.S. and 10 Ph.D. are Range related

Hires:

Currently beginning discussion on a “cluster hire” component in the Wildland Resources Department. The current thought is that this individual will focus on climate-related land cover change. Cluster hires were proposed by interim CNR dean Chris Luecke as a means of hiring multiple faculty by different colleges who have a similar focus. The hope is that these “Clusters” will develop new research initiatives.

Grants/Contracts:

Adler, P. 2011-2014 “A systems approach to seedling establishment on degraded rangeland: Managing ecological processes driving recruitment bottlenecks”. USDA-NIFA, $400,00 total, $22,500 sub-award to USU (PI: J. James, Co-PI: P. B. Adler)
Adler, P. 2012 Research Experience for Undergraduates, NSF, $6670.
Ramsey, R.D., 2012-2014. Quantification of Impervious Surface Area along the Wasatch Front, Utah: An Indicator for Wetland Stress. EPA. $312,000.
Ramsey, R.D., 2012-2013. Cooperative Agreement: Remote Sensing of the Milford Flats Wildfire. BLM. $75,000
Ramsey, R.D., 2012-2015. Computation of National Forest Carbon Budgets. USFS-FIA, $571,000

Web Based Resources:

http://earth.gis.usu.edu/ - Intermountain Region Digital Image Archive
http://earth.gis.usu.edu/swgap/index.html - Southwest Regional Gap Analysis Project Landcover and Related Datasets
http://earth.gis.usu.edu/plants/ - Digital Atlas of the Vascular Plants of Utah.
http://earth.gis.usu.edu/utah/ - Virtual Utah
http://earth.gis.usu.edu/ars/ - Automated Data Extraction Tool

http://extension.usu.edu/rangelands/ - Utah Rangelands Extension Site
http://extension.usu.edu/utahrangelands/ - Rangelands of Utah
This site is currently being automated to provide on-line GIS analysis resources to users

Publications:

Adler, P. B., H. J. Dalgleish and S. P. Ellner. 2012. Forecasting plant community impacts of climate variability and change: when do competitive interactions matter? Journal of Ecology 100: 478-487.

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