

## WERA-40 ANNUAL MEETING 2008

Tucson, AZ

November 12-14, 2008

Meeting opened by Derek Bailey on November 13 at 07:30 am at the La Quinta Inn in Tucson, AZ.

Derek Bailey and Mitch McClaran arranged and provided an excellent tour of ecological sites on the Santa Rita Experimental Range. Oral state reports were given for Arizona, Colorado, Idaho, and Montana at the tour's conclusion.

The meeting reconvened at the La Quinta Inn at 08:00 am on November 14. The minutes of the 2007 WERA-40 minutes were read. Clayton Marlow moved and Pat Johnson seconded acceptance of minutes.

### New Business

*2009 Meeting Location.* The committee will hold the 2009 meeting in Craig County, Colorado September 17-18. Maria Fernández-Giménez will organize the tour of some of her research sites where she is assessing the accuracy of state-and-transition models with stakeholders using empirical data and local sources of knowledge. The tour will be designed to help the committee prepare a symposium on the topic.

*2010 Meeting Location.* The committee will hold the 2010 meeting in Idaho, with specific dates and location to be determined. The tentative plan is to organize a tour of the wildfire complex.

*2010 Symposium.* WERA-40 committee proposed a symposium tentatively titled "Applicability of state-and-transition models across regions." The symposium will examine the model-predicted movements between states due to use of specific tools and relate those predictions to actual outcomes. A unique emphasis will be to include examination of the common tools across regions because of past tendencies to develop models regionally and attempt to apply them universally. A tentative list of speakers was generated including Bob Patton, Pat Johnson, Dan Robinette, Steve Archer, Rick Miller, Fred Pierson, Maria Fernández-Giménez, Chad Prosser, Roger Sheley, and Dave Briske. Regions should include the Great Plains, Southern Deserts, and Great Basin.

*Elections.* Eva Strand was nominated and unanimously elected as secretary for 2009.

*White Paper to SRM Advisory Council.* Due to restructuring of the funding agencies, development of a white paper to influence funding from CSREES for ecological and threshold identification has been tabled.

The WERA-40 committee thanks and welcomes Steve Miller for serving as our new administrative advisor.

Station Reports (full reports are attached)

*University of Arizona reported by Larry Howery.* Department is increasing the number of range majors by increasing electives. Currently, there are 19 undergraduates and 5 graduate students. There are a number of recently appointed administrators and the top current concern is the state's projected debt. Larry is currently evaluating predator effects on grazing behavior.

*Colorado State University reported by Maria Fernández-Giménez.* Department head position search is ongoing. There are 21 undergraduate and more than 40 graduate students. Range curriculum has been revised with more electives and there is a new emphasis on remote and web-based education. There are five range faculty and one extension specialist. Range improvements and range planning courses were lost and an instructor for taxonomy is needed. Range majors are getting 100% employment. See attached report.

*University of Idaho reported by Eva Strand.* The department has eight range faculty, including two new positions in landscape and restoration ecology, and they have added an outreach coordinator. There are 35-40 undergraduates and 10 graduate students. A new B.S. is offered in Fire Ecology & Management. See attached report.

*U.S. Sheep Experiment Station, ARS reported by Corey Moffet.* The station has four SY in range and animal sciences, with one retirement that will not be refilled. Current rangeland research is focused on fire, post-fire grazing in sagebrush steppe, and imagery analysis.

*Montana State University reported by Clayton Marlow.* The department has 57 undergraduate and 7 graduate students and has added three courses. There have been two retirements and they are currently seeking an extension livestock environment specialist. Montana Fish, Wildlife & Parks currently pays for one person to teach wildlife management.

*Livestock and Range Research Laboratory, ARS reported by Lance Vermeire.* The lab has nine animal and range scientists, four are on the Range CRIS. Range research is focused on the interactions of fire, grazing, and weeds. A new scientist was hired to focus on belowground range ecology, particularly microbial communities as they interact with previously mentioned disturbances. Mark Petersen will be Research Leader as of March 2009. See attached report.

*New Mexico State University reported by Derek Bailey.* The department has 46 undergraduate and 11 graduate students. There are six range faculty and three extension specialists. Kirk McDaniel has retired, the position will be filled. Continued close relationship with ARS at Jornada. Virtually 100% employment for undergraduates in range. See attached report.

*North Dakota State University reported by Kevin Sedivec.* There are 10 undergraduates and 12 graduate range majors. Introduction to Range now has 60 students; most are in the natural resources program. There are five range faculty following William Barker's retirement. Plans are to fill the vacancy. Curriculum has been updated with new range planning, wetland classification, and resource scenario courses. See attached report.

*South Dakota State University reported by Pat Johnson.* There are four range faculty with 40-45 undergraduate and 7-8 graduate students in the department. Ranch management option has been added for a remote learning program. Currently searching for a new department head; dean and provost are also retiring soon.

*University of Wyoming reported by Mike Smith.* John Tanaka is the new department head. There are 12 staff members teaching or advising range students (two FTE in extension), seven teaching soils, and five teaching entomology. The department has 110 undergraduate and 25 graduate students. Projects are focusing on reclamation, water, and weed problems. Quentin Skinner has retired. The department was recognized as the best in the university for grant dollars per FTE. The range program is under review for SRM accreditation. See attached report.

## State Reports

Colorado State University  
October 2008

Range Ecology Major, Dept. of Forest, Rangeland & Watershed Stewardship

Undergraduate enrollment: 21 majors, 16 minors

Graduate enrollment: >40 MS & PhD including distance MS degree

Range Ecology Faculty: 5 primary teaching range faculty, 1 range extension specialist

FRWS Faculty: 25

Recent developments: The Range faculty has revised two of our undergraduate Range Ecology major concentrations and these revisions have been passed by the University Curriculum Committee. We are in the process of developing an undergraduate distance degree that will be our third concentration.

Colorado Agricultural Experiment Station Projects in Rangeland Resources

Project Title: Interpretation of Hummocks Relative to the Condition of Riparian Areas and Wetlands

PIs: Paul Meiman, Joe Brummer, Alan Bright, David Cooper

Objectives:

- 1) Characterize how natural resource specialists and private and non-profit stakeholders in Colorado interpret the presence of hummocks in riparian and wetland systems and determine the basis for those interpretations.
- 2) Compile a historical review of hummocks (presence/absence, types and land use implications) in riparian areas and wetlands of the western U.S., based on information available in historical documents and photographs.
- 3) Identify and describe the edaphic, climatic, topographic and vegetative characteristics of riparian wetlands that do, and do not support hummocks; and
- 4) Describe and compare key edaphic, microclimatic, hydrologic and vegetative characteristics of hummocks and interspaces, and interpret those characteristics relative to different theories of hummock formation (including differential freeze/thaw, domestic livestock grazing, erosion and differential litter accumulation).

Title: Examining the effect of collaborative learning on institutional adaptations in response to forest health issues in Colorado

PI: Antony Cheng

Objectives: To understand the collaborative learning mechanisms that foster adaptations in natural resource institutions confronted with issues characterized by high degrees of ecological, economic, and social complexity and uncertainty, specifically, increased wildfire and insect infestation risks to Colorado's forests and surrounding communities. The research will focus on the Front Range Fuels Treatment Partnership Roundtable (the "Roundtable") and the Colorado Bark Beetle Cooperative (CBBC). Both groups involve multiple stakeholders organized to collectively address issues tied to large-scale forest disturbances such as wildfire and mountain pine beetle infestations. The methods utilized in this investigation will include: situation mapping diagrams, questionnaires, semi-structured interviews,

focus groups, choice modeling, and institutional resource analyses. These methods will allow the researchers to measure learning, changes in systems understanding, and the extent of the “zones of agreement” among stakeholders participating in the partnership groups. The outputs of this research can assist these groups and other landscape-scale collaborative conservation efforts achieve their goals more efficiently.

Project Title: Actinorhizal Shrubs in Forests and Rangelands of Colorado

PI: Mark Paschke

Objectives of Project:

The objective of the proposed study is to provide unique and crucial information regarding the basic ecology of actinorhizal shrubs in forest and rangeland habitats in Colorado. Specifically, we will provide the first estimates of the contributions of biologically-fixed nitrogen by actinorhizal shrubs to a variety of forest and rangeland habitats in Colorado.

Project Title: Developing a Geospatial Data and Analysis Center for Conservation Planning in Colorado

PI: Melinda Laituri

Objectives: The geospatial data center that provides data, information, and knowledge useful for conservation planning would create benefits for Colorado through higher quality data and information (consistent, comprehensive, etc.), more time and resource-efficient planning and analysis because of less duplication of datasets, greater defensibility/accountability of natural resource planning, and serving as a catalyst for stronger collaboration and integration among scientists at Colorado State University.

Project Title: Building Technical and Institutional Capacity for Collaborative Adaptive Management of Colorado Rangelands

PIs Maria Fernandez-Gimenez, Jessica Thompson, Monique Rocca

Objectives of Project: The goal of this project is to generate knowledge and develop practical tools that will increase landowner, agency and community capacities to manage Colorado rangelands using a collaborative adaptive management approach.

Three interlinked research and capacity-building objectives support the project’s broad goal:

- 1) Develop ecological state-and-transition (S-T) models as a practical technical tool to facilitate collaborative adaptive management;
- 2) Evaluate the ecological and social processes and outcomes of community-based collaborative resource management (CBCRM) in Colorado; and
- 3) Use the knowledge and tools produced in objectives 1 and 2 to build community, agency and stakeholder capacities for successful collaborative adaptive management.

Other Related Research

Project Title: Participatory Development of Ecological State-and-Transition Models: Integrating Scientific and Local Knowledge for Rangeland Sustainability (NRCS Conservation Incentive Grant)

PI: Maria Fernandez-Gimenez

Project Objectives: 1) Develop S-T models based on ecological field data and professional and local knowledge, using qualitative and quantitative analysis techniques.

2) Use a participatory stakeholder process to compare and evaluate the accuracy and utility of S-T models based on different knowledge sources and data analysis approaches, and to develop “best-fit” models that combine local knowledge and field data. 3) Promote adoption of S-T models through a) direct stakeholder participation in workshops to develop and evaluate S-T models, b) partnerships with local and state-wide organizations to integrate S-T models into existing producer and manager workshops, short-courses, and publications, c) incorporation of S-T models into NRCS site descriptions, and d) publication of the S-T models and a handbook describing their development and use on the Colorado Rangelands and Rangelands West websites.

Project Title: Development of a Data-based Validation Network for State-and-Transition Models (CSREES)

Project Collaborator: Maria Fernandez-Gimenez (PIs David Briske and Ben Wu at Texas A&M)

Project Objectives: This project seeks to underpin the state-and-transition model framework, which represents the primary technology for rangeland assessment, with a network of long-term empirical data. Research objectives are to 1) explore new protocols to construct STMs that are based on empirical ecological data, 2) investigate the ecological validity of existing qualitative STMs by comparing them with data-based models, and 3) evaluate the decision rules and assumptions that various authors utilize to construct STMs.

Project Title: Linking Ecological and Economic State-and-Transition Models for Adaptive Management of Rangeland Ecosystems (NRI Managed Ecosystems)

PIs: Maria Fernandez-Gimenez, Monique Rocca, James Pritchett, Roy Roath

Project Objectives: 1) Identify states and transitions for key ecological sites within the sagebrush steppe biome of NW Colorado, and quantify and value selected ecosystem services associated with each state. 2) Create and validate a linked ecological and economic S-T model. 3) Develop an innovative outreach program to help ranchers and land managers become familiar with S-T models and the feedback between ecosystem services and economic decisions. 4) Promote adoption of S-T models by ranchers and other land managers through a combination of participatory research, extension workshops, integration of curriculum units into existing Cooperative Extension and related short courses and workshops, and delivery through web media including the RangelandsWest website and eExtension. 5) Evaluate the effectiveness of the extension component by assessing changes in stakeholder knowledge, attitudes, management and monitoring practices, and their adoption or non-adoption of linked S-T models as decision-making tool for adaptive management.



## Rangeland Update from the University of Idaho

**Working at Landscapes Scales** — "We create knowledge and foster understanding for the stewardship and management of rangelands."

### New Developments

- New faculty member in **Applied Landscape Ecology** (August 2007), Dr. Eva Strand, with expertise in GIS and habitat modeling.
- Growing emphasis in **Restoration Ecology** with arrival of Dr. Beth Newingham.
- Continued excellence in **Rangeland Extension** and service to land owners through new faculty member Dr. Kelly Crane.
- **Outreach Coordinator**, Lovina Roselle, added to staff to create and deliver information about rangelands. Strong collaboration with the Idaho Rangeland Resources Commission.
- **Heady Professorship** supports work of rangeland faculty. Dr. Lee Vierling is the current Heady Professor examining ways to use remote sensing to define rangeland health.
- New B.S Degree in **Fire Ecology and Management** jointly administered with the Forest Resources Department. Grown to more than 60 students in first year of offering.
- Continued **strong student recruitment**. Current undergraduate enrollment 35-40 students. We continue to seek students interested in working in the rangeland management profession.

**Continued involvement with stakeholders and commitment to working landscapes.**



### Current Faculty

- **Stephen Bunting**  
Rangeland Ecology and Fire Ecology
- **Kelly Crane**  
Rangeland and Livestock Management
- **James Kingery**  
Forest Range Relationships and Rangeland Restoration
- **Karen Launchbaugh**  
Grazing Management and Wildland Weed Management
- **Beth Newingham**  
Wildland Restoration Ecology
- **Ronald Robberecht**  
Ecophysiology and Information Technology in Ecology
- **Eva Strand**  
Applied Landscape Ecology and GIS applications in natural resources
- **Lee Vierling**  
Spatial ecology and remote sensing
- Plus Collaborative work with Neil Rimbey (Range Economics), Alistair Smith (Vegetation Assessment) and J.D. Wulffhorst (Rural Sociology).

Dr. Karen Launchbaugh  
Department Head  
Rangeland Ecology & Management  
University of Idaho  
Moscow, ID 83844-1135  
(208) 885-4394  
range@uidaho.edu

**Recent Research**  
**Rangeland Ecology and Management**  
**University of Idaho**

**Rangeland Ecosystems**

Smith, S.D., T.N. Charlet, L.F. Fenstermaker, and B.A. Newingham. 2007. Effects of Global Change on the Mojave Desert Ecosystem. In: *The Mojave Desert: Ecosystem Processes and Sustainability*. Eds: Webb, R.H., J.M. André, L.F. Fenstermaker, J.S. Heaton, D.L. Hughson, E.V. McDonald, and D.M. Miller. University of Arizona Press.

Strand, E.K., L.A. Vierling, and S.C. Bunting. 2007. A spatially explicit model to predict future landscape composition of aspen woodlands under various management scenarios. *Ecological Modelling* (in press).

Strand, E.K., L.A. Vierling, A.M.S. Smith, and S.C. Bunting. 2008. Net changes in aboveground woody carbon stock in western juniper woodlands, 1946-1998, *Journal of Geophysical Research-Biogeosciences* 113. G01013

Newingham, B.A., F. Bassirrad and R.M. Callaway. 2007. Allocating nitrogen away from an herbivore: A novel compensatory response to root herbivory. *Oecologia* 153:913-920.

Strand E.K., A.P. Robinson, and S.C. Bunting 2007. Spatial patterns on the sagebrush steppe/ Western juniper ecotone. *Plant Ecology* 190:159-173

**Fire Ecology and Management**

Launchbaugh, K.L., B. Brammer, M.L. Brooks, S.C. Bunting, P. Clark, J. Davison, M. Fleming, R. Kay, M. Peilunt, D. Pyke, and B. Wylie. 2008. Interactions among livestock grazing, vegetation type, and fire behavior in the Murphy Wildland Fire Complex in Idaho and Nevada, July 2007: *U.S. Geological Survey Open-File Report* 2008 1214, 42 p.

Bunting, S.C., E.K. Strand and J.L. Kingery. 2007. Landscape characteristics of sagebrush steppe/juniper woodland mosaics under varying modeled prescribed fire regimes. Pp. 50-57, in R.E. Masters and K.E.M. Galley, eds. *Proceedings of the 23rd Tall Timbers Fire Ecology Conference: Fire in grassland and shrubland ecosystems*. Tall Timbers Research Station, Tallahassee, Florida, USA.

**Invasive Plant Management**

Frost, R.A., L.M. Wilson, K.L. Launchbaugh and E.M. Howde. 2007. Seasonal change in forage value of rangeland weeds in North Idaho. *Invasive Plant Science and Management* 1:(in Press.)

Wallace, J.M., L.M. Wilson and K.L. Launchbaugh. 2008. The Effect of Targeted Grazing and Biological Control on Yellow Starthistle (*Centaurea solstitialis*) in Canyon Grasslands of Idaho. *Rangeland Ecology and Management* 61:314-320.

---

Newingham, B.A., P. Vidale and J. Belnap. 2007. Microhabitat effects of canopy, litter and herbivory on emergence and success of *Hemus tectorum*. *Journal of Arid Environments* 10:389-402.

### **Grazing and Foraging**

Frost, R.A., K.L. Launchbaugh and C.A. Taylor, Jr. 2008. Age and body condition of goats influence consumption of juniper and monoterpene-treated feed. *Rangeland Ecology and Management* 61:48-54.

Fraker-Marble, M.J., K.L. Launchbaugh and J.W. Walker. 2007. Differences in food ingestion and digestion among sheep classified as high or low sagebrush consumers. *Rangeland Ecology and Management* 60:191-194.

Lopez-Ortiz, S., J.A. Pfister, K.L. Launchbaugh and C.C. Gay. 2007. Forage availability and body condition affect intake of lupine (*Lupinus leucophyllus*) by Grazing Cattle. *The Professional Animal Scientist* 23:450-456.

### **Landscape Ecology and Remote Sensing**

Falkowski, M.J., A.M.S. Smith, P.E. Gessler, A.T. Hudak and L.A. Vierling. 200\_. The influence of forest canopy cover upon the accuracy of two LiDAR-based individual tree measurement algorithms. *Canadian Journal of Remote Sensing* (In press)

Garrity, S.R., L.A. Vierling, A.M.S. Smith, M.J. Falkowski and D.B. Hann. 200\_. Automatic detection of individual shrub location, crown area, and cover using spatial wavelet analysis (SWA) of high spatial resolution aerial photography. *Canadian Journal of Remote Sensing* (In press)

Lanspergy, K.E. and R. Robberecht. 200\_. The efficacy of aerial photography analyses for determining disturbances in aquatic ecosystems. *Canadian Journal of Remote Sensing*. (In press)

Lentile, L.B., A.M.S. Smith, A.T., Hudak, P. Morgan, M. Bobbitt, S.A. Lewis and P. Robichaud, P. 200\_. Remote sensing for prediction of 1-year post-fire ecosystem condition. *International Journal of Wildland Fire* (In press)

Smith, A.M.S., R. Wynne and N. Coops, 200\_. Special issue on the Remote Characterization of Vegetation Structure and Productivity: Plant to Landscape Scales. *Canadian Journal of Remote Sensing* (In press)

Smith A.M.S., E.K. Strand, C.M. Steele, D.B. Hann, S.R. Garrity, M.J. Falkowski and J.S. Evans, 200\_. Production of vegetation spatial-structure maps by per-object analysis of juniper encroachment in multi-temporal aerial photographs. *Canadian Journal of Remote Sensing* (In press)

Clawges, R., K.T. Vierling, L.A. Vierling and E.M. Rowell. 2008. The use of lidar remote sensing to estimate avian species diversity, density, and occurrence in a pine/aspen forest. *Remote Sensing of Environment* 112:2064-2073

Jensen, J.R., K.S. Humes, L.A. Vierling and A.T. Hudak. 2008. Discrete return lidar based prediction of leaf area index in two conifer forests. *Remote Sensing of Environment* 112:3947-3957.



---

Smith, A.M.S., J.A. Greenberg and L.A. Vierling. 2008. Introduction to special section: The remote characterization of vegetation structure: New methods and applications to landscape-regional-global scale processes. *Journal of Geophysical Research-Biogeosciences* 113:G03S51.

Vierling, K.T., L.A. Vierling, W. Gould, S. Martinuzzi, and R. Clawges. 2008. Lidar: Shedding new light on habitat characterization and modeling. *Frontiers in Ecology and the Environment* 6:90-98.

Hancock, A.L., E.K. Strand, and K.L. Launchbaugh. 2007. Wish upon a satellite: Applying GPS to range and management. *Rangelands* 29:51-55.

Lewis, J.S., J.L. Rachlow, T.O. Garton and L.A. Vierling. 2007. Effects of habitat on GPS collar performance: Using data screening to reduce location errors. *Journal of Applied Ecology* 44:653-671.

Podewicz, A., L.A. Vierling, L. Lentile and R. Smith. 2007. View angle effects on relationships among MISR vegetation indices, leaf area index, and burn severity in a ponderosa pine forest. *Remote Sensing of Environment* 107:322-333.

Storfer, A., M.A. Murphy, J.S. Evans, C.S. Goldberg, S. Robinson, S.F. Spear, R. Dezzani, T. Delmelle, L.A. Vierling, and L. Waits. 2007. Putting the "landscape" in landscape genetics. *Heredity* 98:128-142.

### **Rangeland Management and Economics**

Donovan, S., C. Looney, T. Hanson, Y. Sanchez-de Leon, Tim Hatten, J.D. Wulforst, M. Jennings, S.D. Eigenbrode, J. Johnson-Maynard, and N.A. Bosque-Pérez. 2007. Reconciling social and biological needs in an endangered ecosystem: the Palouse as a model for bioregional planning. *Ecology and Society* (in press)

Pocewicz, A., M. Nielson-Pincus, C. Goldberg, M. Johnson, P. Morgan, J. Force, T.P. Waits and L.A. Vierling. 2008. Predicting land use change: Comparison of models based on landowner surveys and historical land cover trends. *Landscape Ecology* 23:195-210.

Rimpey, N.R., L.A. Torell and J.A. Tanaka. 2007. Why Grazing Permits Have Economic Value. *Journal of Agricultural and Resource Economics* 32:20-40.

## Fort Keogh Livestock & Range Research Laboratory Report - 2008

State: Montana

### Scientists:

Lee Alexander	Molecular geneticist	406-874-8234
Tom Geary	Reproductive physiologist	406-874-8215
Mike MacNeil	Quantitative geneticist	406-874-8213
Kurt Reinhart	Ecologist	406-874-8211
Matt Rinella	Weed Ecologist	406-874-8232
Andy Roberts	Reproductive physiologist	406-874-8216
Lance Vermeire	Rangeland Ecologist	406-874-8206
Richard Waterman	Range Nutritionist	406-874-8208

### MSU Extension:

Larry Brence	Eastern Region Dept. Head	406-874-8236
Rachel Endecott	State Beef Extension Specialist	406-874-8286

### Current Rangeland Research projects and investigators:

#### Proactive Management for Sustainable Rangeland Production

Investigators	<b>SY</b>
Lance Vermeire (Lead Scientist)	1.00
Kurt Reinhart	1.00
Matt Rinella	1.00
Richard Waterman	0.50
Vacancy	1.00
Vacancy	0.90

#### PROJECT SUMMARY

The planned research is designed to improve sustainability of rangeland production by addressing the interacting effects of disturbances on stability and integrity of rangelands and efficiency of livestock nutrient conversion. Objectives are to: 1) Develop strategies and decision tools to proactively manage livestock grazing, fire, and drought impacts on Great Plains community structure and function; 2) Improve animal productivity and product quality based on predicted nutrient intake, forage dynamics, and diet selection processes in the northern Great Plains; and 3) Develop management strategies to restore rangelands degraded by weeds and prevent weed invasions in the northern Great Plains. Experiments are integrated across objectives and will determine the interacting effects of grazing, fire, drought, and invasive plants on plant communities (production, species composition, diversity, heterogeneity, propagation, and survival) and the effects of changes in vegetation and animal physiology on livestock (weight gain, distribution, diet quality, diet selection, diet diversity, foraging efficiency, forage intake, and rumen microbial diversity). Two experiments are replicated across three locations (Miles City, MT, Nunn, CO and Woodward, OK) to determine ecological ramifications of fire seasonality, return interval, and grazing interactions in semiarid rangelands on a north-south gradient across the western Great Plains. Understanding the mechanisms that control disturbance effects on rangelands and animal responses to alterations in the plant community will promote development of proactive management strategies for improved stability in rangelands and rangeland livestock production systems.

#### OBJECTIVES

The long-term objective of this project is to develop proactive management strategies that improve sustainability of rangeland production through increased rangeland stability, efficiency of nutrient conversion, and community integrity. Over the next 5 years we will focus on the following objectives:

Objective 1: Develop strategies and decision tools to proactively manage livestock grazing, fire, and drought impacts on Great Plains community structure and function.

Sub-objective 1.A. Determine plant community and livestock response to post-fire grazing deferment.

Sub-objective 1.B. Determine plant community response to fire return interval and seasonality.

Sub-objective 1.C. Determine patch burning effects on plant community dynamics, animal performance, grazing distribution, and foraging efficiency.

Sub-objective 1.D. Characterize grazing history effects on rangeland integrity and stability.

Objective 2: Improve animal productivity and product quality based on predicted nutrient intake, forage dynamics, and diet selection processes in the northern Great Plains.

Sub-objective 2.A. Determine effects of forage quality on autumn forage intake as it interacts with cow lactation and gestation status.

Sub-objective 2.B. Determine rumen microbial response to noxious weed consumption by sheep and cattle.

Objective 3: Develop management strategies to restore rangelands degraded by weeds and prevent weed invasions in the northern Great Plains.

Sub-objective 3.A. Determine interacting effects of fire and grazing on annual brome dynamics.

Sub-objective 3.B. Provide weed management protocols adjusting for inter-annual variation.

Sub-objective 3.C. Develop an internet-available system to quantify site-specific invasive weed impacts.

Sub-objective 3.D. Develop grazing strategies to reduce invasive weed population growth rates.

Sustainability of rangeland production hinges on the stability of the plant community because changes in species composition, forage production, and forage quality fundamentally affect the animal community. The primary forces of change in rangelands are grazing, fire, weather, and alien plants. This research was designed to determine the consequences of these disturbances as they interact to affect the plant and animal communities. Objective 1 addresses the interacting effects of grazing, fire, and weather on native plant communities and ties in with Objective 2 by assessing those effects on animal performance, diet quality, and foraging efficiency. Objective 2 builds on Objective 1 by determining how diet composition and forage quality affect nutrient availability and intake by livestock and leads into Objective 3 by identifying ruminal mechanisms that affect livestock consumption of invasive weeds. Finally, Objective 3 extends the interactions of grazing, fire, and weather from Objective 1 to invasive weeds by examining their effects on weed establishment and control, and supports Objective 2 by determining livestock species effects on weed establishment through diet selection.

Much of this work is multi-disciplinary and involves significant cooperation among Fort Keogh scientists as well as collaborators listed in the Appendix. Internal collaboration by objective is as follows: Objective 1 – Vermeire, Waterman, and Reinhart; Objective 2 – Waterman; Objective 3 – Rinella, Reinhart, and Vermeire. As noted in Milestones, most of this work spans more than one review cycle due to its long-term nature or pre-treatment sampling.

#### Concurrent Projects:

Potential impact of rumen microbial fermentation and ecology of noxious weeds consumption by range livestock

Converting crested wheatgrass stands to native rangeland

Effect of soil-borne fungal pathogens on forest diversity and dynamics

FY 2008 Rangeland Publications:

- Boggs, K. M., M. Sturdy, D. J. Rinella, and **M. J. Rinella**. White spruce regeneration following a major spruce beetle outbreak in forests on the Kenai Peninsula, Alaska. *Forest Ecology and Management* 255:3571-3579. 2008.
- Branson, D.H. and **Vermeire, L.T.** 2007. Grasshopper egg mortality mediated by oviposition tactics and fire intensity. *Ecological Entomology* 32:128-134.
- Kruse, R.E., M.W. Tess, **E.E. Grings**, R.E. Short, **R.K. Heitschmidt**, W.A. Phillips, and H.S. Mayeux. Evaluation of beef cattle operations utilizing different seasons of calving, weaning strategies, postweaning management, and retained ownership. *The Professional Animal Scientist* 24:319-327. 2008.
- MacNeil, M.D., M.R. Haferkamp, **L.T. Vermeire**, and J.M. Muscha. Prescribed fire and grazing effects on carbon dynamics in a northern mixed-grass prairie. *Agriculture, Ecosystems & Environment* 127:66-72. 2008.
- Rinella, M. J.**, M. L. Pokorny, and R. Rekaya. Grassland invader responses to realistic changes in native species richness. *Ecological Applications* 17:1824-1831. 2007
- Vermeire, L.T.**, R.K. Heitschmidt, and M.R. Haferkamp. Vegetation response to seven grazing treatments in the Northern Great Plains. *Agriculture, Ecosystems & Environment* 125:111-119. 2008.
- Wylie, B.K., E.A. Fosnight, T.G. Gilmanov, A.B. Frank, J.A. Morgan, **M.R. Haferkamp**, T.P. Meyers. Adaptive data-driven models for estimating carbon fluxes in the Northern Great Plains. *Remote Sensing of Environment* 106:399-413. 2007.

North Dakota State University: Presented by Kevin Sedivec, Ext. Rangeland Specialist

### Range Education Program

The Range Program is NO longer part of the Animal and Range Sciences Department. A new School was developed and finalized in late 2007/early 2008 called School of Natural Resource Sciences. Within the School, students can receive a B.S., M.S. and Ph.D. degree in Range, Soils, NRM, or Entomology. Most students are in the growing NRM program. A total of 150 undergraduates are within the School, with ~10 Range Majors. The School has 52 graduate students, with 3 Range faculty have 12 of the students (3 range). Most non-range faculty NRM graduate students are with the social option, followed by range, soils and entomology. A Total 22 faculty positions are within the School (10 in soils).

William Barker retired in July 2008, leaving 5 range faculty position (1.25 Administration (Kirby-Director of School, Grygiel – Program Leader of NRM), 1.5 Teaching (Kirby, DeKeyser, Biondini, Grygiel), 1.55 Research (DeKeyser, Biondini, Sedivec), and 0.7 Extension (Sedivec – Program Leader of Range), and 1 lecturer (Hargas – Wetland/Range Ecologist). We have re-classified DeKeyser to replace Barker's position as botanist/wetland scientist/range ecologist. We will fill the open position with a Range Scientist/Ecologist starting March 1, 2009 advertising.

We have updated our curriculum, adding a new capstone course in Range Planning and Management. We also added a course in Wetland Classification and Function, and a Resource Scenario course. Currently have 3 taxonomy courses, 4 ecology courses, 6 range courses, and 2 wetland/hydrology courses.

#### Research Trials involving Ecological Site Description, State, and/or Transitions

#### **Wetlands, Wet Meadow and Subirrigated Ecological Sites within MLRA 53B and 55B**

- 1) Three-Tiered Wetland Condition Assessment in Missouri Coteau to develop a Rapid Assessment Model. DeKeyser, Hargas and Kirby. Funded by Dept. of Health and Environmental Protection Agency.

#### **Loamy Overflow and Loamy Terrace Ecological Sites, and Riparian Zones within MLRA56**

- 2) Describe different states and transitions of Riparian Zones under different management scenarios within the Red River Valley of North Dakota and Minnesota. DeKeyser, Sedivec, Zeleznk, and Norland. Funded by Dept. of Health and Environmental Protection Agency.

#### **Loamy, Thin Loamy, Loamy Overflow, and Sandy Ecological Sites; and Green Ash Woody Draws within MLRA 54, 58C, and 58D**

- 3) Determine baseline species composition (diversity, richness, and production) of rangelands on western North and South Dakota public Forest Service lands by habitat type/ecological site. Sedivec, Schauer and Gearhardt. Funded by USDA Forest Service.

#### **Loamy and Loamy Overflow Ecological Sites within MLRA 53B, 55C, and 55B**

- 4) Impacts of long-term grazing intensities (1988-present) of twice-over rotation grazing system, versus season long grazing, on plant species composition and herbage production in western North Dakota. Manske. Funded within the Dickinson Research and Extension Center of NDSU.

State: New Mexico

Faculty list: researchers, extension, ARS with e-mail and/or phone numbers

	Phone	E-mail / fax
Dept. Animal & Range Sciences	(575) 646-2514	(505) 646-5441
Laurie Abbott	646-2870	<a href="mailto:labbot@nmsu.edu">labbot@nmsu.edu</a>
Kelly Allred	646-1042	<a href="mailto:kallred@nmsu.edu">kallred@nmsu.edu</a>
Derek Bailey	646-2554	<a href="mailto:dwbailey@nmsu.edu">dwbailey@nmsu.edu</a>
Andres Cibils	646-4342	<a href="mailto:acibils@nmsu.edu">acibils@nmsu.edu</a>
Sam Fernald	646-1041	<a href="mailto:fernald@nmsu.edu">fernald@nmsu.edu</a>
Jerry Holechek	646-1649	<a href="mailto:holechek@nmsu.edu">holechek@nmsu.edu</a>
Kirk McDaniel (retired)	646-1191	<a href="mailto:kmcdanie@nmsu.edu">kmcdanie@nmsu.edu</a>

Extension

Sam Smallidge – Range	646-5944	<a href="mailto:ssmallid@nmsu.edu">ssmallid@nmsu.edu</a>
Terrell (Red) Baker – Riparian	646-2218	<a href="mailto:ttbaker@nmsu.edu">ttbaker@nmsu.edu</a>
Jon Boren – Wildlife (Assist. Dean)	646-1164	<a href="mailto:jboren@nmsu.edu">jboren@nmsu.edu</a>
Keith Duncan – Brush Control	748-1228	<a href="mailto:erbc@nmsu.edu">erbc@nmsu.edu</a>

USDA-ARS Jornada Experimental Range <http://usda-ars.nmsu.edu/>

	(575) 646-4842	(575) 646-5844
Dean Anderson		<a href="mailto:deanders@nmsu.edu">deanders@nmsu.edu</a>
Jerry Barrow		<a href="mailto:jbarrow@nmsu.edu">jbarrow@nmsu.edu</a>
Brandon Bestelmeyer		<a href="mailto:bbestelm@nmsu.edu">bbestelm@nmsu.edu</a>
Joel Brown		<a href="mailto:joelbrow@nmsu.edu">joelbrow@nmsu.edu</a>
Rick Estell		<a href="mailto:restell@nmsu.edu">restell@nmsu.edu</a>
Jeff Herrick		<a href="mailto:jherrick@nmsu.edu">jherrick@nmsu.edu</a>
Kris Havstad		<a href="mailto:khavstad@nmsu.edu">khavstad@nmsu.edu</a>
Deb Peters		<a href="mailto:debpeter@nmsu.edu">debpeter@nmsu.edu</a>

Undergraduate range students: 46

Graduate range students: 11

Current research projects and investigators:

NMSU Department of Animal and Range Sciences

Laurie Abbott	Disturbance effects on vegetation and soil dynamics on New Mexico rangelands: Implications for restoration and management. African rue reproductive ecology.
Kelly Allred	Systematic and floristic studies of southwestern plants.
Derek Bailey	Management of cattle behavior to achieve specific goals: Genetic selection of adapted animals and prescribed grazing. Potential of supplements to increase intake of honey mesquite leaves.
Andres Cibils	Management of one-seed juniper using sheep and goats as biological control agents. Behavioral approaches to manage cattle in rangelands containing locoweed.

	Low level aerial photography for long-term rangeland monitoring
Sam Fernald	Land use effects on runoff and water quality on upland watersheds and along stream corridors. Flow measurement for improved acequia water management. Vegetation treatment effects on forest runoff and sediment yield Time domain reflectory monitoring to runoff, erosion and sediment transport in Pinon-Juniper Woodland Watersheds
Jerry Holechek	Effect of two stocking levels on cattle production, forage production and financial returns in the Chihuahuan Desert.

Recent graduate theses:

Biggs, J. R. 2007. Patch use dynamics of rocky mountain elk (*cervus elaphus nelsoni*) following the cerro grande fire. NMSU Ph.D. Thesis.

Buerdsell, S. L. 2007. History, ecology, and biological control of russian olive. NMSU MS Thesis.

Combs, N. D. 2007. Evaluation of clopyralid/triclopyr aerial applications to mesquite in eastern new mexico. NMSU MS Thesis.

Fink, R. W. 2007. A floristic inventory of salinas peak, white sands missile range. NMSU MS Thesis.

Franco, J. G. 2007. Management of saltcedar regrowth with carpet-roller applied herbicide. NMSU MS Thesis.

Gallegos, J. A. 2007. Evaluation of litter hydrology in ponderosa pine and mixed conifer stands in northern new mexico. NMSU MS Thesis.

Martin, J. A. 2008. Factors affecting locoweed (*oxytropis* and *astragalus* sp) ingestion by yearling cattle. NMSU MS Thesis.

Moeny, J. C. 2008. Control of smooth brome and restoration of native plant communities in the kelly hayfields of grand teton national park. NMSU MS Thesis.

Pollak, E. 2007. Evaluation of low-stress herding and supplement placement to modify cattle distribution and improve pronghorn habitat. NMSU MS Thesis.

Ramirez Garduno, H. 2007. Influence of juniper control and understory defoliation on herbaceous vegetation and soil moisture. NMSU MS Thesis.

Strahan, R. T. 2008. A floristic survey of the vascular plants of the milnesand prairie preserve, roosevelt county, new mexico. NMSU MS Thesis.

Wesley, R. 2008. Influence of socially-induced and inherited behaviors on feeding site selection of cattle and sheep. NMSU MS Thesis.

Recent NMSU Publications:

Abbott, L., G.T. Bettman, and T. Sterling. 2008. Physiology and recovery of African rue (*Peganum harmala*) seedlings under water deficit stress. *Weed Science* 56:52-57.

Bailey, D.W. and F.D. Provenza. 2008. Mechanisms determining large-herbivore distribution. *In:* H. H. T. Prins and F. van Langevelde [EDS.]. *Resource ecology: spatial and temporal dynamics of foraging*. Dordrecht, Netherlands: Springer. p. 7-28.

Bailey, D.W. and D. Jensen. 2008. Research note: method of supplementation may affect cattle grazing patterns. *Rangeland Ecology and Management* 61:131-135.

Bailey, D.W., H.C. VanWagoner, R. Weinmeister, and D. Jensen. 2008. Evaluation of low-stress herding and supplement placement for managing cattle grazing in riparian and upland areas. *Rangeland Ecology and Management* 61:26-37.

Bailey, D.W., H.C. VanWagoner, R. Weinmeister, and D. Jensen. 2008. Comparison of low-moisture blocks and salt for manipulating grazing patterns of beef cows. *Journal of Animal Science* 86:1271-1277.

Black-Rubio, C., A. Cibils, R. Endecott, M. Petersen, and K. Boykin. 2008. Piñon-juniper woodland use by cattle in relation to weather and animal reproductive state. *Rangeland Ecology and Management* 61:394-404.

Cibils, A., L.D. Howery, G.B. Ruyle. 2008. Social models fail to induce diet and feeding site avoidance in naïve yearling steers. *Animal: An International Journal of Bioscience* 2:255-264.

Godfrey Khumalo, G., J. Holechek, M. Thomas, and F. Molinar. 2008. Soil depth and climatic effects on desert vegetation dynamics. *Rangeland Ecology and Management* 61:269-274.

Goulart, R.C.D., M. Corsi, D.W. Bailey, and S.S. Zocchi. 2008. Research note: cattle grazing distribution and efficacy of strategic mineral mix placement in tropical Brazilian pastures. *Rangeland Ecology and Management* 61:656-660.

Seedang, S., A.G. Fernald, R.M. Adams, and D.H. Landers. 2008. Economic analysis of water temperature reduction practices in a large river floodplain: An exploratory study of the Willamete River, Oregon. *River Research and Applications* 7:941-959.

Toledo, P.D., L.B. Abbott, and J.E. Herrick. 2008. Cover pole design for easy transport, assembly, and field use. *Journal of Wildlife Management* 72:564-567.



University of Wyoming, Renewable Resources Department

Head search just completed. John Tanaka to start in 2009.  
SRM accreditation review under way, 12-13 Nov.

Students: 110 under graduates, 25 ± graduate students  
Faculty/staff (AP): 26 total; 12 that reportedly teach or advise REWM students; Soils 7; Entomology 5  
Retirements on hold pending resuscitation of stock market.  
One of better departments at UW for grant \$ per FTE.

Grant Titles for Renewable Resources 10/08  
AGENCY, ABBREVIATED TITLE, PI

LSRCD DATA ANALYSIS AND INTERPRETATION OF THE MUDDY CREEK WATERSHED WATER QUALITY MONITORING PROG, SKINNER/REDDY  
WY AG APPLD RESEARCH/DEVEL OF GRASSHOPPER PEST MANAGEMENT PRACTICES IN WY, LATCHININSKY  
UWCASH/SER DUTIES OF SER ASSOC DIRECTOR FOR ACADEMICS, REDDY  
DEVELOPMNET OF AN ISOTOPE FACILITY FOR NEON  
MT ST UNV BIG SKY PARTNERSHIP PHASE II OF C SEQUESTRATION PROJECT RENEW, VANCE/SCHUMAN/DERNER  
USDA CSREES MECHANISMS/IMPACTS OF INTEGRATED PEST MGMT FOR SUSTAINABLE DALMATION TOADFLAX CNTRL/WESTERN US, ENLOE/COLLIER/MEIMAN  
INTL ATOMIC ENERGY AGCY PARTITIONING EVAPORATION/TRANSPIRATION IN FLOOD-IRRIGATED FIELDS + ISTOTOPIC NON-STEADY STATE TRANSPIRATION, WILLIAMS  
DOE RES/DEV CBNG PRODUCED WATERS INVESTIGATIONS TASK 9 RISK ASSESSMNT/WEST NILE VIRUSE RESULTING FRM CBNG WTRS, MILLER/ZOU/SIVANPILLAI  
UWCASH DOE TASK 3 DISPOSAL PONDS IN POWDER RIVER BASIN, REDDY/CHEN  
UWCASH DOE TASK 7 ENHANCING THE BENEFICAL USE OF CBNG WATERS, VANCE/URYNOWICZ  
DOE RES/DEV CBNG PRODUCED WATERS INVESTIGATIONS TASK 7 ENHANCING THE BENEFICAL USE OF CBNG WATERS, VANCE/URYNOWICZ  
UWCASH DOE TASK 9 RISK ASSESSMNT/WEST NILE VIRUS RESULTING FRM CBNG WTRS, MILLER/ZOU/SIVANPILLAI  
DOE RES/DEV CBNG PRODUCED WATERS INVESTIGATIONS TASK 3 DISPOSAL PONDS IN POWDER RIVER BASIN, REDDY/CHEN  
USDA FOR SERV POSTFIRE REGROWTH OF RIPARIAN AND UPLAND VEGETATION/ROUTT NTL FOREST  
CA, U OF, GLOBAL LIVESTOCK COLLABORATIVE RESEARCH 07-08  
SAGE-GROUSE NESTING AND BROOD REARING HABITAT  
WY DEQ AML MECHANISMS FOR STABILIZATION & ACCUMULATION OF ORGANIC CARBON IN RECLAIMED MINE LAND SOILS, STAHL  
ND, U OF, REMOTE SENSING APPLICATIONS TO RANGELAND PEST MONITORING IN NORTHERN GREAT PLAINS, LATCHININSKY  
USDA CSREES SABBATICAL RESEARCH ON THE USE OF ZEOLITIC MATERIALS FOR AG AND NVIRO QUALITY ENCHANCEMENT, VANCE  
ARMY EFFECTIVENESS OF NATIVE PLANTS AS COMPETITORS/NON INDIGENOUS AND INVASIVE KNAPWEED/THISTLE SPECIES, HILD  
WY AG WY CAPS PROGRAM CORE PROJECT, LATCHININSKY  
BIOLOGICAL CONTROL, GRASSHOPPER AND GYPSY MOTH PROGRAMS FY08  
NPS ARE BOER GOATS EFFECTIVE WEED MANAGEMENT TOOLS, OLSON  
WWDC TRACING GLACIAL ICE AND SNOW MELTWATER WITH ISOTOPES, WILLIAMS

AF CANADA THISTLE AND WILLOW CONTROL IN GAURA HABITAT ON FE WARREN AFB,  
HILD/COLLIER/PAIGE

AF CANADA THISTLE AND WILLOW CONTROL IN GAURA HABITAT ON FE WARREN AFB,  
HILD/COLLIER/PAIGE

USDA ARS GIS METHODS TO ASSESS BIO-GEOGRAPHIC/CLIMATE EFFECTS ON CAPACITY,  
MILLER

UW SER MECHANISMS BY WHICH SAGEBRUSH FACILITATES RECOVERY OF DISTURBED  
STEPPE ECOSYSTEMS, WILLIAMS,/STAHL/ENDALL/EWERS/WAIBEL/WILLIAMS/HUBERT/COUPAL

WY G+F MOOSE HABITAT ECOLOGY AND ASSESSMENT IN THE SNOWY MOUNTAIN RANGE OF  
SE WY 05-06, OLSON

NORTHERN AZ UNIV DIRECT/INDIRECT EFFECTS OF WARMING, ELEVATED CO2 AND PLANT  
INVASION ON CARBON AND WATER CYCLES IN GRASSLAND

UW CASH NAZU DIRECT/INDIRECT EFFECTS OF WARMING, ELEVATED CO2 AND PLANT  
INVASION ON CARBON AND WATER CYCLES IN GRASSLANDS, WILLIAMS/PENDALL

SARE PDP SMITH

WWD NEW METHOD FOR TRACING SEEPAGE FROM CBNG WATER HOLDING PONDS IN  
POWDER RIVER BASIN, WY SHARMA/REDDY/FROST

SURFACE COMPLIANCE INTERNSHIP

WATER QUALITY MONITORING TRAINING

WA ST U, INNOVATIVE FLY MGMT STRATEGIES ON PASTURED AND RANGELAND BEEF CATTLE  
IN THE WESTER REGION, LATCHININSKY

USDA ARS INVESTIGATE HOW GRASSLAND ECOSYSTEMS /RISING ATMOSPHERIC  
CO2/CLIMATE CHANGE, WILLIAMS

NSF CLLBRTV RSRCH/CATERPILARS AND PARASITIDS IN THE ANDES OF EASTERN  
ECUADOR, SHAW

LACHAT QUIKCHEM 8500 FLOW INJECTION ANALYZER

CARBON SEQUESTRATION

CSU COORDINATED AG WATER QUALITY PROGRAMMING FOR THE NORTHERN PLAINS/MNTNS  
REGION, SKINNER/REDDY

WY DEQ GROUNDWATER RECHARGE IN THE HIGH PLAINS AQUIFER, BELVOIR RANCH,  
WYTURNER

USDA SCREES EFFECTS OF CROPPING-SYSTEM-RELATED SOIL MOISTURE/NUTRIENT  
DYNAMICS ON THE SUSTAINABILITY OF SEMIARID DRYLAND AGRICULTURE,  
NORTON/STAHL/KELLENSERS/KRALL/PECK/FROST/MOUNT

WY DEQ EVALUATION OF BEST MANAGEMENT PRACTICES (BMPS) TO PROTECT  
GROUNDWATER QUALITY IN GOSHEN COUNTY, WY, REDDY/WENZEL

HABITATS FOR GREATER SAGE-GROUSE POPULATIONS-ATLANTIC RIM, WY

USGS AVIAN AND VEGETATION INVENTORY AT BROWNS PARK NATIONAL WILDLIFE REFUGE,  
CO, HILD/PAIGE

UWCASHSER WY RECLAMATION/RESTORATION CENTER, WILLIAMS

UWCASHSER CBM PRODUCED WATER RESEARCH, REDDY

CLEAN COAL TECHNOLOGY

APPLIED RESEARCH ON INTEGRATED GRASSHOPPER PEST MANAGEMENT

WYOMING SOIL MOISTURE NETWORK

NSF ISOTOPIC RECORD OF RESPONSE TO CLIMATE CHANGE IN SPINES OF SAGUARO  
CACTUS, WILLIAMS

AZ, UNIV OF DEVEL RANGELAND DECISION SUPPORT TOOL TO IMPROVE RANGELAND  
WATERSHED MANAGEMENT DECISIONS, PAIGE/MILLER

UWCASHSER IDENTIFYING DISTURBANCE MECHANISMS INFLUENCING HABITAT SELECTION BY  
ELK/NATURAL GAS DEVEL FIELDS

UT ST U WESTERN REGION SARE PDP STATE GRANTS WYOMING 7-11

GAS WELL RECLAMATION AND TOPSOIL MANAGEMENT

BLM OIL AND GAS SURFACE COMPLIANCE INTERNSHIP, WILLIAMS  
IDENTIFYING DISTURBANCE MECHANISMS INFLUENCING HABITAT SELECTION BY ELK/NATURAL  
GAS DEV  
SERCD SAGE CREEK WATER QUALITY STUDY 1998-2005 FINAL REPORT  
ARTI DEVELOP A METHOD TO REMOVE ARSENIC SPECIES FROM WATER, REDDY  
CSU COACHED PLANNING FOR LANDHELP PROJECT, SMITH  
UT ST U IMPLEMENT SARE PDP FOR WY 02-03, SMITH  
DIAMOND J RANCH ENHANCE ELK PRODUCTION THROUGH HABITAT, OLSON  
VAR SPON RESEARCH MILEAGE, BREWER  
WASHAKIE CO WEED + PEST SALT CEDAR CONTROL IN BIG HORN RIVER, HILD/WHITSON  
WY AG REDUCED AREA-AGENT GRASSHOPPER MANAGEMENT, LATCHININSKY  
WY WEED SUPPORT FOR BIOLOGICAL CONTROL POSITION, COLLIER  
WV UNV IDENTIFICATION OF ALEIODES OF EASTERN FORESTS, SHAW  
VARIOUS SPONSERS-WILLIAMS, STEVE  
BELLE AYR MINE STUDY ON THE EFFECTS OF STOCKPILING AND REPLACEMENT ON SOIL  
CARBON POOLS, STAHL/WICK  
GAS WELL RECLAMATION AND TOPSOIL MANAGEMENT