Cattlemen's Update 2007

(Cattlemen's Update is an annual educational program offered by the University of Nevada for beef cattle producers. Program topics speak to current beef cattle production management issues in the Great Basin region affecting profitability and product quality. Subject matter selection is based on a needs assessment of Nevada beef cattle producers and on concerns and trends expressed by the leaders of the beef cattle industry in the United States.)

Welcome to the 2007 edition of the Cattlemen's Update Proceedings. This year finds us with good cattle prices and a strong demand for beef products; among many other things. The cattle business is changing forever. With things like BSE, National Livestock Identification, marker assisted DNA selection, alliances, other marketing schemes, and the continuing advances of technology; the business is different and will be different forever. There are some new issues and some just beyond the horizon. Using corn for fuel production is going to have a big impact on the cattle business and a bigger impact on pork and poultry. Exactly how this will affect the cattle business is largely unknown. The bio-fuels program is gaining momentum and livestock are the major competitors for corn. Clones are soon to affect the National ID program. While there is apparently no problem (research on this is still limited) for clone meat in the food supply, consumers for the most part do not want it. Can you prove the bulls or semen that you used do not come from a clone or an animal with a clone in its history? With a good ID program in place you probably can. The business is becoming more complicated, and our competition now comes from not only down the road, but also around the world. The cattle business is no longer just weaning a calf and selling in the fall, but a business of providing a specific product that performs in a certain way to create something to sell to the population that they want. It is through forums like this, as well as the new forms of education (the Internet, email, etc.), that provide the ability to stay on top and survive to make a profit in the business.

Livestock producers with a computer and e-mail can participate at anytime in an educational forum by using Extension Coffee Shop (a subscribed e-mail list). Coffee Shop is designed to help solve problems and face issues in the livestock industry. Call Ron Torell (775-738-1721) or Dr. Ben Bruce (775-784-1624) to participate if you are not a member.

SPONSORS

University of Nevada Cooperative Extension; University of Nevada College of Agriculture; Biotechnology and Natural Resources; USDA-RMA Commodity Partnership Program; Fort Dodge Animal Health; Nevada Department of Agriculture; Nevada Cattlemen's Association; Intermountain Farmer's Association; Walco International; Humboldt & Churchill County CattleWomen; Lextron Animal Health; American AgCredit; Neff Mill; Pfizer Animal Health; Intermountain Beef Producers; Churchill County Park and Recreation Department; Pinenut Livestock Supply (John Keithly); Quinn Henley DVM; Ron's Seed and Supply (Ron Schrempp); Snyder Livestock Bulls (Lucy Rechel); Wellington Community Hall; and local Ely Sponsors: Gilbert Griffin, Carter Agri-Systems; Hal Bybee, Cedar Grove Pet Resort; John Giannoli, First National Bank of Ely; Lance Gale, Gale Oil & Tire; Brian Revard, Pfizer, Inc.; Steve Smith, Stockman's Supply; Tom Sanders, Jr., DVM, White Pine Veterinary Clinic; and Ronnie Gardner, Steptoe Valley Inn.

PROGRAM SPEAKERS

Cattle Handling and Faculty Design	n
	Dr. Lynn Locatelli, Practitioner, Benkelman, Nebraska
Cattle Disease Risk Management	Dr. David Thain, State Extension Veterinarian
Improving Great Basin Wildrye	Dr. Ben Bruce, State Extension Livestock Specialist
Profit Tips	Ron Torell, Area Extension Livestock Specialist
•	fication Coordinator, Nevada Department of Agriculture
Area Nevada Programs	Local Veterinarians

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The Nevada Rangeland Monitoring Handbook Second Edition Now Available

Sherman Swanson, Ben Bruce, Rex Cleary, Bill Dragt, Gary Brackley, Gene Fults, James Linebaugh, Gary McCuin, Valerie Metscher, Barry Perryman, Paul Tueller, Diane Weaver, and Duane Wilson,

In 1980-1984, Nevada rangeland managers recognized the importance of monitoring for managing livestock grazing and came together to create the *Nevada Rangeland Monitoring Handbook*. Published in 1984 by the Nevada Range Studies Task Group of the Nevada Range Committee, the Handbook united rangeland managers behind an agreed upon set of procedures. It helped many people agree about monitoring methods and management changes without resorting to confrontation and courts. More importantly, progress in the management of Nevada rangelands led to better rangeland conditions in many areas.

The 1984 Nevada Rangeland Monitoring Handbook recommended the following studies to be conducted at key areas: 1) Production – The NRCS Double Sampling Method and the BLM Weight Estimate Vegetation Inventory Method, 2) Quadrat Frequency, and 3) The Modified Key Forage Plant Method utilization transect. Production data were compared with NRCS ecological site descriptions to determine ecological status. Frequency indicated changes in plant composition. These methods are still valid. The Modified Key Forage Plant Method has been replaced by the Key Species Method. Production data may be interpreted differently as ecological site descriptions are being revised to reflect more recent ecological thought. Production data compared with ecological site descriptions help determine ecological state. They may be compared with Desired Plant Community (DPC) objectives. Frequency studies emphasize nested plots to make data more useable through time as communities change.

While the first Handbook proved useful, it is more than 20 years old. As monitoring is a tool for learning from ongoing management to adjust and improve management, it is fitting that we learn from our past experiences in monitoring to create a new synthesis of current ideas. The Second Edition of the Nevada Rangeland Monitoring Handbook is available at http://www.unce.unr.edu/pubs.html.

The 1984 Handbook emphasized monitoring techniques without emphasizing the reasons for monitoring. Today, management is based on goals and objectives set in a planning process that considers the best science and society's mix of values. Monitoring in the 1980s focused almost exclusively on livestock grazing management. Today, we recognize that, as important as this is, herbivory is only one aspect of land management, and that some monitoring of vegetation change is needed to track and manage problems such as modified fire regimes and invasive weeds that are not resolved with livestock management alone. Riparian issues were not addressed in the first handbook. Today, we have learned the importance of riparian monitoring for adjusting management.

State and federal agencies and range consultants have come together again to formulate this second edition. We asked others for creative help and comment to make it as useful as possible for the management of Nevada rangelands. The sections of this handbook include:

A FRAMEWORK FOR MONITORING

OBJECTIVES

Ecological Sites

Riparian Areas

Inventory and Assessment of Base Resources

Land Use Planning - Large Scale

Resource Objectives

ADAPTIVE MANAGEMENT

TRIGGERS AND INDICATORS

MONITORING METHODS – GENERAL CONSIDERATIONS

Statistical Considerations

Key Areas

Key Species

Short-Term Monitoring

Long-Term Monitoring

Roles

MONITORING METHODS - SHORT-TERM MONITORING

Grazing Use Records

Photography

Project Implementation Records

Weather Data

Insects, Disease, and Rodents

Use Mapping

Uilization

Residual Vegetation / Stubble Height

Woody Species Use

Streambank Alteration

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Remote Sensing

Frequency

Production

Canopy/Foliar Cover

Ground Cover

Community-Type Transects

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Riparian Shrubs

Streambank Stability

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Vegetation Measurement Across an Edge of a Community Type

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Use Differentiation Among Wildlife, Livestock, Wild Horses, and Burros, etc.

Phenology

Fire-related Monitoring

Exclosures and Comparison Areas

Grazing Response Index

Apparent Trend

DEVELOPING A MONITORING PLAN

INTERPRETATION AND USE OF MONITORING DATA

Because of the importance of permittees becoming engaged in the process of actively managing the allotments they graze and the private land they own or lease, this handbook emphasized cooperative monitoring. This handbook includes Appendix-A, a stand-alone *Rangher's Monitoring Guide*. Other appendices include:

Cooperative Monitoring

Ecological Sites

Drought,

Establishing Good Objectives,

Adaptive Management,

Procedures For Selecting Key Areas And Key Species,

Remote Sensing To Monitor Rangelands,

Use Mapping, Key Species Method, and Proper Use;

Growing Condition Indicator Checklist,

Frequency Sampling Procedures,

Production and Plant Community Objectives,

Ground Cover and Canopy Cover Measurements;

Monitoring Plan Tables,

Interpretation and Use Of Monitoring Information

Rangeland Management Agency Offices in Nevada,

Glossary, and

References

Appropriate use of this handbook assumes basic levels of professionalism, common sense, objectivity, education, experience, mentoring, and proper application of techniques. Every rangeland management and monitoring case is unique, depending on the initial conditions, site potential, objectives, level of management capabilities (economics, personnel, logistics, etc.), and the relationships among the participants. Where differences (real or imagined) between agency regulations, policy, or guidance and the information provided in this handbook arise, the relevant regulation, policy, or guidance will be used. However, it is intended that this Handbook and the *Rancher's Monitoring Guide* will meet agency requirements.



Carson City Office: 251 Jeanell Drive, Suite 3 Carson City, Nevada 89703-2148 (775) 684-5333 Fax (775) 684-5340

Las Vegas Office: 2300 McLeod Street Las Vegas, Nevada 89104-4314 (702) 486-4690 Fax (702) 486-4695

DEPARTMENT OF AGRICULTURE

350 Capitol Hill Avenue
Reno, Nevada 89502-2923
Telephone (775) 688-1180 • Fax (775) 688-1178
Website: http://agri.state.nv.us

Elko Office: 1351 Elm Street Elko, Nevada 89801-3364 (775) 738-8076 Fax (775) 738-2639

Winnemucca Office: 1200 E. Winnemucca Boulevard Winnemucca, Nevada 89445-2999 (775) 623-6502 Fax (775) 625-1200

January, 2007 Cattlemen's Update

The office of the State Veterinarian for Nevada is pleased to take part in the 2007 Cattlemen's Update. As Animal ID Coordinator for the State, it has been a worthwhile experience in terms of the public outreach, education and participation on behalf of the National Animal Identification System (NAIS).

As you may be aware, the Nevada Department of Agriculture (NDOA) through the office of the State Veterinarian entered into a contract with the United States Department of Agriculture (USDA) for the Nevada programs. The first step, premises registration is what I would like to address.

First and foremost, the program is **VOLUNTARY** and **CONFIDENTIAL.** At the October, 2006 meeting of the US Animal Health Association, Under Secretary for Marketing and Regulatory Programs Bruce Knight stated "I think the most important thing for everybody to recognize is this is a voluntary program." The data gathered is to be accessed on an as-needed basis and not available to other federal agencies. Confidentiality is a primary concern and the Under Secretary will remain aggressive to tighten rules on confidentiality within NAIS.

Premises registration is by physical location, i.e. address. There is no fee to register and we do not collect number information of any species. Nevada's program is protected under NRS 561.285 passed during the last Legislature. This section defines confidential and proprietary information.

Your premises registration will enable State officials to communicate information regarding a potential or actual disease outbreak in affected areas, identify species which may be affected, symptoms to look for and who to contact; i.e. herd origin. This is also an opportunity to communicate prevention and security information as may be needed. The intention has been and remains the ability to achieve rapid deployment in the event a trace back process is necessary.

Attached are a Registration Form and a direction sheet. Please complete the form and return it as indicated at your earliest opportunity. If you have any questions, please contact 775/688-1180 Ext. 236 or email hpecetti@agri.state.nv.us. The forms and additional information is available at the NDOA website on the State of Nevada Homepage and USDA at ww.usda.gov./nail/.

NEVADA BOARD OF AGRICULTURE

Thank you for your cooperation and support of Nevada's programs,

Holly Pecetti, Program Officer 1 Animal Identification Coordinator

National Animal Identification System/Premises Registration Form

This form has been developed by the office of the Division of Animal Health, Nevada State Veterinarian's Office. The goal of premises registration is to achieve a rapid trace back should the need arise to respond to disease outbreak or bioterrorism/agro-terrorism attack which may pose a threat to the nation's food supply.

Please read the following points before completion of the attached form:

- Premises registration applies to a physical address and the name (s) of the legal property owner (s). Should property ownership change, the registered number stays with the address. Notification of the change should be promptly made to the State Animal ID Coordinator at the State Veterinarian's office of NDOA.
- Premises registration is not related to brand(s) registration. A brand number may be used as a State ID number to cross-refer contact information.
- This is not a program of numbers. We do not collect the number(s) of species, only the primary three (3) species on the premises.
- Age and source verification is becoming increasingly critical to feedlot managers, processors and international trade. The unique 7-digit number is included on the individual animal identification tags and group lot tags for sheep, swine, and poultry. This system allows producers who are registered and their animals identified to obtain the highest market value for their livestock.
- Once a premise has been registered, a card is mailed providing the producer the information necessary to start the animal identification process to coincide with current business practices.
- Website information: State of Nevada Homepage> Department of Agriculture> Animal Industry or What's New. Return completed form information:

Nevada Department of Agriculture Holly Pecetti, Program Officer 1 350 Capitol Hill Ave Reno, Nevada 89502

email at hpecetti@agri.state.nv.us

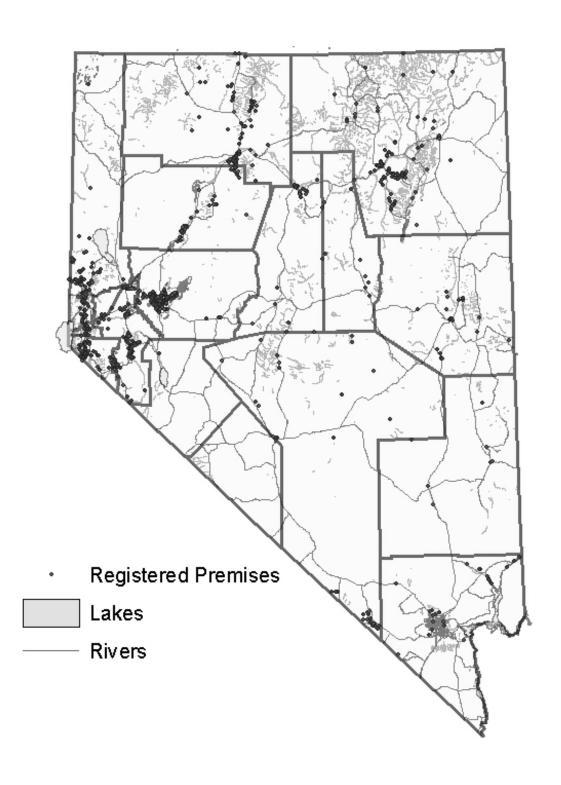
Fax: 775/688-1733

Questions: 775/688-1180 ext. 236

• Please do not hesitate to contact me if there are any questions related to form completion or if you need further information.

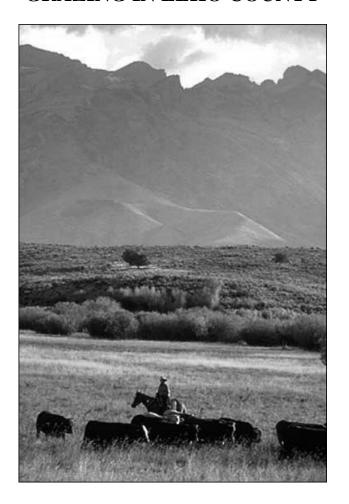
Premises Name NEVADA PRE	MISES REGISTRATION FORM
Premises Owner- First:	Premises Owner-Last
Physical Address for UPS delivery or Emergency Service	es Response
City	State ZipCode County:
	INV
JS Postal Service Mailing Address :	
 Mailing City:	Mailing State: Mailing Zipcode:
Contact Information First Name Cont.	act Information Last Name
NV Brand Registration Number	Other State Brand Registration Number
Phone Number	Cell Phone Number
THORIO TRAINING	
Fax Number	
E-mail	
OTHER LOCATION INFORMATION	
Latitude	Longitude
,	
Checkoff Species: Beef Dairy	SheepGoatsHorses Swine Poultry
Comments and other information	
Please fill out and fax to: 775-688-1733 or	For Questions Please Call Holly Pecetti at
Mail To: NDOA	775-688-1180 ext. 236
Att. Holly Pecetti 350 Capitol Hill Ave	NEVADA PREMISES REGISTRATION FORM
Reno, NV 89502	

Nevada NAIS 11/06/06 1084 Registered Premises



TECHNICAL REPORT UCED 2006/07-03

ANALYSIS OF IMPACTS OF PUBLIC LAND GRAZING ON THE ELKO COUNTY ECONOMY AND MOUANTAIN CITY MANAGEMENT AREA: ECONOMIC IMPACTS OF FEDERAL GRAZING IN ELKO COUNTY





ANALYSIS OF IMPACTS OF PUBLIC LAND GRAZING ON THE ELKO COUNTY ECONOMY AND MOUANTAIN CITY MANAGEMENT AREA: ECONOMIC IMPACTS OF FEDERAL GRAZING IN ELKO COUNTY

Jonathan Alevy Elizabeth Fadali and Thomas R. Harris

- Jonathan Alevy is a Research Assistant Professor in the Department of Resource Economics at the University of Nevada, Reno.
- Elizabeth Fadali is a Research Associate in the University Center for Economic Development in the Department of Resource Economics at the University of Nevada, Reno.
- Thomas R. Harris is a Professor in the Department of Resource Economics and Director of the University Center for Economic Development at the University of Nevada, Reno.

PHOTO IS OF THE RUBY MOUNTAINS IN ELKO COUNTY NEVADA: NEVADA COMMISSION ON TOURISM

May 2006

This publication, Analysis of Impacts of Public Land Grazing on the Elko County Economy and Mountain City Management Area: Economic Impacts of Federal Grazing in Elko County was published by the University Center for Economic Development in the Department of Resource Economics at the University of Nevada, Reno. Funds for this publication were provided by the Elko County Commissioners, the United States Department of Commerce, Economic Development Administration University Centers Program contract #07-66-05878. publication's statements, findings, conclusions, recommendations, and/or data represent solely the findings and views of the authors and do not necessarily represent the views of the Elko County Commissioners, the U.S. Department of Commerce, the Economic Development Administration, University of Nevada, Reno, or any reference sources used or quoted by this study. Reference to research projects, programs, books, magazines, or newspaper articles does not imply an endorsement or recommendation by the authors unless otherwise stated. Correspondence regarding this document should be sent to:

Thomas R. Harris, Director
University Center for Economic Development
University of Nevada, Reno
Department of Resource Economics
Mail Stop 204
Reno, Nevada 89557-0105
Phone: 775/784-6499



UCED
University of Nevada, Reno
University Center for Economic Development
Department of Resource Economics

Analysis of Impacts of Public Land Grazing on the Elko County Economy and Mountain City Management Area: Economic Impacts of Federal Grazing in Elko County

Executive Summary

The University Center for Economic Development completed an analysis of the economic impacts to Elko County of federal grazing permits as an input to cattle ranching. The results of this study can be used as background material for public lands management policies.

Historic Trends in Livestock Production in Elko County

- Beef cattle inventory for Elko County in 2006 was estimated to be 152,000 head.
- Beef cattle inventories have fluctuated over the past 30 years but have displayed an overall downward trend.
- Sheep and lamb inventory for Elko County in 2006 was estimated to be 19,700 head.
- Sheep and lamb inventories have displayed an even stronger downward trend than cattle inventories over the past 30 years and in 2006 were only 36% of 1975 levels.
- Sales of cattle made up more than 95% of livestock receipts to Elko County according to 2002 Census of Agriculture data.
- Elko County real net farm proprietor's income totaled \$11.5 million and incorporated farm income was \$18.3 million in 2004.
- Average operator age is increasing in Elko County and in the U.S. as a whole.
- Elko County average ranch size has decreased from 8,745 acres in 1987 to 6,227 in 2002.
- Operator characteristics data may indicate an increase in so-called lifestyle ranches, whether by choice or by default, and potential issues regarding a lack of younger operators for ranch succession plans.

Livestock Economics

• A linear programming model that simulates a representative Elko County ranch operation was used to examine potential impacts to Elko County ranches due to changes in federal grazing land availability.

- Average annual net cash income for the representative ranch under current conditions was \$53,442. With a 25%, 50%, 75% and 100% reduction in federal AUM availability, average annual net cash income decreased to \$46,134, \$35,560, \$8,703 and \$-80,757 respectively.
- The probability of bankruptcy for the Elko County representative ranch was less than 1% if federal AUM reductions were less than 50%. Likelihood of bankruptcy increased to 12% at a 75% reduction and 96% in the case that no federal grazing is available.
- The variability of ranch profits increased as reductions in federal AUM availability increased.
- There were an estimated 847,000 permitted AUMs in Elko County in 2006. Approximately 85% of these were BLM allotments with the remaining allotments on the Humboldt-Toiyabe National Forest.
- There were an estimated 73,000 permitted AUMs in the Mountain City Ranger District and nearly 28,000 in the Jarbidge Ranger District.
- In 1997 in Elko County, 177 ranches or 68% of operations with beef cow inventories held federal grazing permits.
- The value of production associated with one AUM for beef cattle in Elko County was estimated to be \$38. Total economic impact in Elko County from production value of one AUM was estimated to be \$68.
- For every 1,530 AUMs available for cattle production in Elko County, one job was generated. Earnings per job generated by cattle production were estimated to be an average of \$20,700 per year.
- Using the information above about one AUM, the 847,000 Federal grazing permits in Elko County could generate \$32.6 million in cattle production, \$57.3 million in total economic activity, \$11.4 million in labor earnings and 553 jobs.
- For the Mountain City Ranger District, 73,100 AUMs can generate \$2.8 million in cattle production output, \$4.9 million in total economic activity in Elko County, \$987 thousand in labor earnings and 48 jobs.
- For the Jarbidge Ranger District, 27,600 AUMs can generate \$1.1 million in cattle production output, \$1.9 million in total economic activity in Elko County, \$373 thousand in labor earnings and 18 jobs.

- In certain circumstances, one AUM of federal grazing land may be more valuable than an average AUM in production of cattle. This depends on factors such as seasonal dependency, the extent of a given ranch's dependence on federal grazing, availability of substitutes and ranch viability issues. From a ranch production perspective, one AUM of federal grazing land in Elko County could be associated with as much as \$84 in value of cattle production.
- From the ranch production perspective total economic impacts from one AUM of federal grazing are associated with as much as \$148 of total economic activity, \$30 of labor earnings and 0.0014 jobs. This implies one job per 714 AUMs of federal grazing.
- Using the ranch production perspective, total labor income associated with all permitted federal AUMs in Elko County would be \$25.0 million representing 1,212 jobs.

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I. Introduction

Leased Bureau of Land Management (BLM) and United States Forest Service (USFS) land are an integral part of ranch production in Elko County, Nevada. The area of Elko County is approximately 11,000,000 acres of which over 70 % or nearly 8,000,000 acres are federal lands (Zimmerman and Harris 2000). A previous survey of ranches in northeastern Nevada found only 4 out of 56 ranches that did not use federal land for grazing. On average the ranches used federal rangeland to provide 49% of the feed requirements for their animals (Torell et al. 1981).

Because of the multiple use character of Federal BLM and USFS lands, reduction of availability of federal grazing is often under consideration. For example, recently changes in federal grazing land management have been under consideration in Elko County because of concerns over wildlife habitat for Lahontan cutthroat trout, sage grouse and other species (Bureau of Land Management 2006; Harding 2006). It is clear that reducing access to available animal unit months (AUMs) of grazing will increase costs and reduce profits for ranchers in Elko County. This report quantifies these losses to ranchers. In addition, economic losses to ranchers have an effect on the local economy. Cattle sector exports bring money into the Elko County economy which then cycles through the economy, helping to support other sectors such as local wholesalers and retailers, and providing wages to employees. These economic impacts related to federal grazing in Elko County are also quantified in this report.

The focus of this report is economic impacts related to ranch production. Ranch production of cattle in Elko County is a basic industry. In 2003, the Cattle Ranching and Farming Sector in Elko County recorded a value of output of \$53.8 million which was 2.95% of total county value of output. This ranks the Cattle Ranching and Farming Sector eighth in value of output of Elko County's 142 economic sectors. The sector had export sales of \$43.5 million which was 5.77% of total Elko County exports, which ranks the Cattle Ranching and Farming Sector fourth highest in export sales of Elko County's 142 economic sectors. The Cattle Ranching and Farming Sector is of significant economic importance to Elko County (Fadali and Harris 2006).

This report does not attempt to quantify existence or use benefits from any potential increases or decreases in wildlife, tourism or lifestyle use of the grazing lands, although these values may also be important. Any potential costs associated with overgrazing or changes to long-term productivity of the land are also not considered here. The assumption is made that

AUM availability reported by federal agencies is sustainable usage. In addition, other possible benefits or costs of ranchland such as provision of open spaces, barriers to residential development, or interactions with the fire cycle are not considered.

II. Historic Trends in Elko County Livestock Production¹

Cattle Production

Beef cattle inventory for Elko County in 2006 was estimated to be 152,000 head. Inventory over the period from 1975 to 2006 ranged from a high of 215,000 head of beef cattle in 1975 to a low of 147,000 head in 1993. Although there was some fluctuation due to cyclical movements in the cattle industry and other factors, there was an overall decline in beef cattle inventory over the period from 1975 to 2006 as is illustrated by the trend line (in black). Tables 8 and 9 in Appendix A contain the complete data series used in Figures 1, 2, 3 and 4.

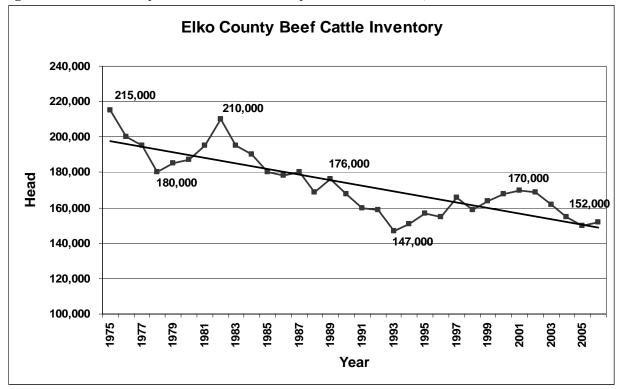


Figure 1. Elko County Beef Cattle Inventory with Trend Line, 1975-2006

Data source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006

In Figure 2, beef cattle inventory over the period 1975 to 2006 for the state of Nevada and for Elko County is graphed as a percentage of 1975 inventory. Again, there are fluctuations but the downward trend in both indices is clear. Both state and county inventories do not reach

.

¹ This report follows portions of Foulke, T., R. H. Coupal and D. T. Taylor (2006). <u>Implications for the Regional Economy from Changes in Federal Grazing: Park County, Wyoming</u>. Western Regional Science Association, 45th Annual Meeting, Santa Fe, NM, University of Wyoming Department of Agricultural and Applied Economics.

above 80% of 1975 levels from 1991 onwards. In 2006, beef cattle inventories for Elko County and the state of Nevada were 71% and 76% of 1975 levels, respectively.

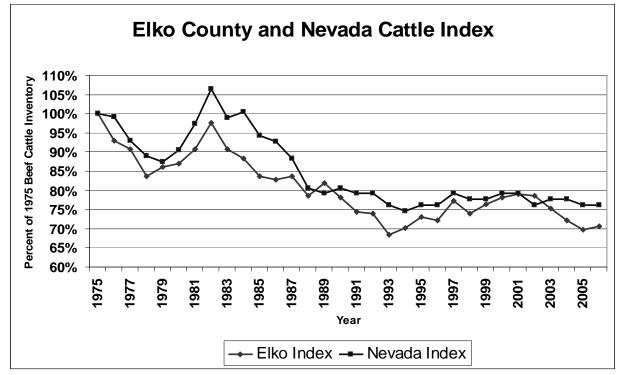


Figure 2. Elko County and Nevada Beef Cattle Index, 1975-2006.

Data source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006, UCED analysis.

Sheep Production

Sheep production makes up a small portion of total livestock sector activity in Elko County. Beef cattle production dominates, making up 95% of livestock sector receipts in 2002 (NASS 2004). Never-the-less, in 2006, sheep and lamb inventory in Elko County was estimated to be 19,700 head. As shown in Figure 3, there has been an even steeper decline in Elko County sheep and lamb inventories over the period from 1975 to 2006 than in beef cattle inventories. The high over the period occurred in 1975 at 54,000 head, while the low occurred in 1995 at 10,000 head. Figure 4 shows how Elko County declines in sheep and lamb inventory have been similar to but greater than declines in the state of Nevada inventory. Elko County inventories in 2006 were 36% of 1975 levels while Nevada inventories were 49% of 1975 levels. A nationwide decline in sheep and lamb inventories occurred over the same period. Inventories in the U.S. in 2006 were only 43% of 1975 levels. Many reasons have been posited for this decline such as

labor costs and availability, synthetic fiber, imports, food preferences, predator control, lack of innovation in the industry, and competition from other meat sources.

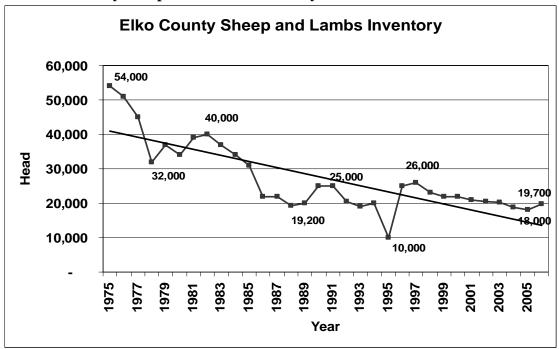


Figure 3. Elko County Sheep and Lambs Inventory with Trend Line

Data source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006

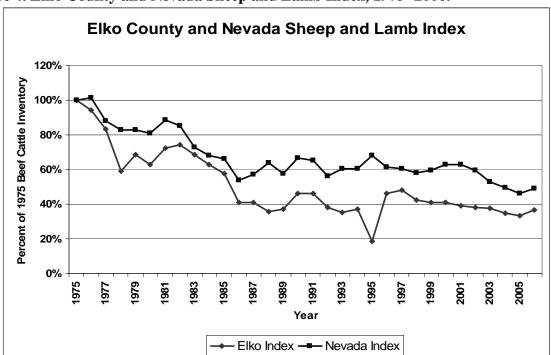


Figure 4. Elko County and Nevada Sheep and Lamb Index, 1975-2006.

Data source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006, UCED analysis

Operator Demographics and Operation Size Trends

As shown in Figure 5, real net farm proprietors' income has been volatile over the period from 1969 to 2004, the period of record for Regional Economic Information Systems data. Real net income for incorporated farms has been somewhat less volatile over the period. Both series have been adjusted for inflation to 2004 dollars. For proprietors in Elko County, the highest net income was in 1973 at \$20.6 million (2004 dollars) and the lowest was in 1985 when farm proprietor's lost \$5 million (2004 dollars). For corporate farms the highest income also occurred in 1973 at \$14.9 million (2004 dollars). The second highest corporate farm income in Elko County was in 2004 (\$11.5 million). The lowest corporate farm income year was 1979, when farm corporations in Elko County lost \$10.2 million (2004 dollars). Negative incomes for both corporate farms and farm proprietors in Elko County occurred from 1977 to 1979, 1981 to 1986 and in 1996. The 1980s marked a particularly difficult period for the U.S. cattle industry as a whole. The cattle cycle that occurred from 1979 to 1990 marked the first time that a cattle inventory cycle peak did not break a new record. In addition, the liquidation phase of this cycle

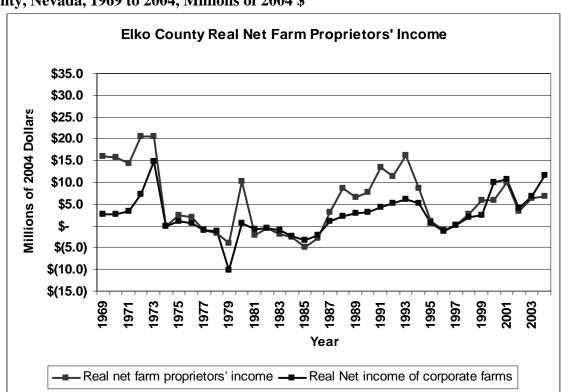


Figure 5. Net Farm Proprietor's Income and Net Income of Corporate Farms, Elko County, Nevada, 1969 to 2004, Millions of 2004 \$

Data source: Regional Economic Information Systems (Bureau of Economic Analysis 2006), UCED analysis.

lasted eight years instead of the average of four years. Cheaper competing meats and changes in consumer preferences are thought to have been the causes of the 1980s prolonged cattle cycle and the failure to set new record highs in the cycle peak (Anderson et al. 1997).

Figure 6 shows the total estimated number of Elko County ranch operators for each of the years that the Census of Agriculture has been taken from 1978 to 2002. Except for a decline from 1997 (436 operators) to 2002 (397 operators), there has been an upward trend in number of operators from 272 in 1978 to 397 in 2002². Figure 6 also shows the number of ranch operators by age group over the period. There is an increase in the numbers of operators who are 65 and over from 48 in 1978 to 109 in 2002. The number of operators in the youngest age group under 35 years fluctuated, and ultimately failed to replace itself, while the 35 to 44 year old operators increased from a low of 39 in 1978 to a high of 90 in 2002. The 45 to 64 year old age group increased over the period also, but more modestly from 156 to 183 operators. The shift toward an older population of operators may reflect national trends in aging. The growth in the 35 to 44 year age group and the shrinking of the youngest age group of under 35 year olds may also reflect national demographic trends of the baby boom and baby bust generations. Elko County, however, experienced a growth rate of 4.3% in the number of people in the 20 to 34 year old age group over the years 1990 to 2000 while the United States as a whole experienced a loss in the number of people in this age group of 5.4%. Average age in Elko County (31.2) has been far younger than average age statewide (35.0) or nationally (35.3), (Census Bureau 2001). Taken together, these demographics may raise some eventual concerns about ranch succession plans as the large number of ranch operators 65 and older retire and the large baby boom generation also reaches retirement age.

Figure 7 shows the changing distribution of ranch size in Elko County from 1982 to 2002. From Figure 7, a general trend towards smaller ranch size can be observed. While the number of ranches with less than 9 acres actually decreased from 59 to 50 ranches over the period, there was nearly a doubling of the number of ranches with 9 to 49 acres from 39 ranches to 75 ranches. For the largest ranches with 2000 or more acres there was a decrease of 20 ranches from 127 to 107. Overall, the number of ranches with less than 260 acres increased by approximately 30% while the number of ranches with more than 260 acres decreased by

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² 1997 and 2002 estimates from the Census of Agriculture are not entirely comparable with earlier years because of a change in weighting procedures, so the amount of the increase is not precise (Harris, 2006).

approximately 17% over the period from 1982 to 2002. Figure 8 shows how average ranch size has changed from 1987 to 2002 for ranches greater than 260 acres in size and for ranches less than 260 acres in size. Ranch size for larger ranches decreased from an average of approximately 15,000 acres to 13,100 acres, while average size for smaller ranches increased from 62 acres to 72 acres. This may indicate some increase in so-called lifestyle ranches and a corresponding decrease in the larger more commercially oriented livestock operations in Elko County.

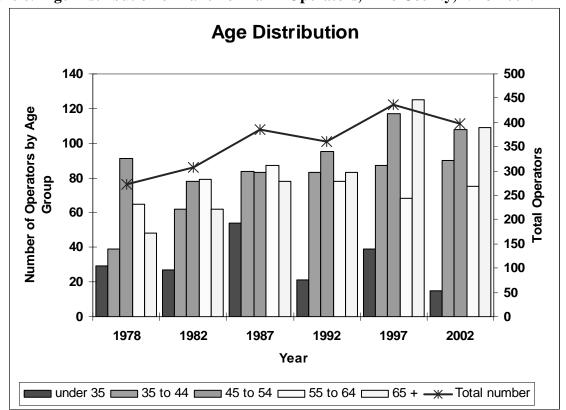


Figure 6. Age Distribution of Ranch or Farm Operators, Elko County, 1978-2002.

Data source: National Agricultural Statistics Service 2004. E-mail from Amanda Pomicter, Caudill Library, Marketing and Information Services Office, NASS.

Figure 9 shows Elko County ranches by value of sales for Census of Agriculture years from 1987 to 2002. The number of ranches with \$2,500 or less in sales increased from 81 in 1997 to 141 in 2002. The value of sales for ranches may differ dramatically from year to year depending on cattle prices and other cyclical factors. The large increase in number of ranches with sales less than \$2,500 in 2002, however, occurred despite an improved real net farm income in 2002 when compared with 1997. This may indicate both a consolidation of profits amongst

larger outfits and an increase in "hobby" ranching, whether due to the difficulty of turning a profit or to preference.

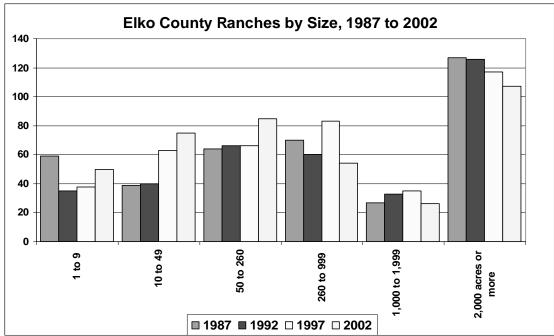


Figure 7. Number of Elko County Ranches by Size in Acres, 1987 to 2002.

Data source: National Agricultural Statistics Service 2004, UCED analysis

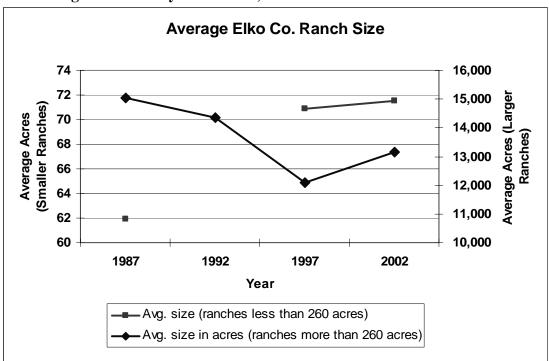


Figure 8. Average Elko County Ranch Size, 1987-2002

Data source: National Agricultural Statistics Service 2004, UCED analysis

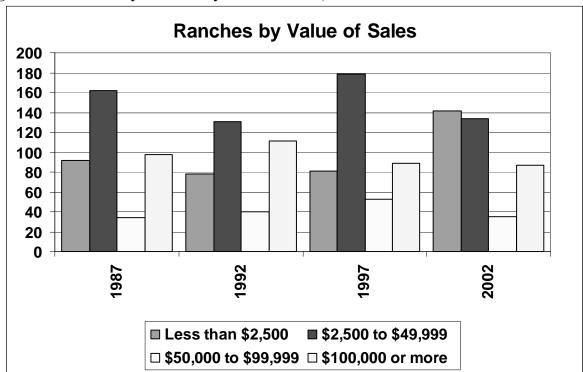


Figure 9. Elko County Ranches by Value of Sales, 1987-2002.

Data source: National Agricultural Statistics Service 2004, UCED analysis

III. Livestock Economics

GAMS Model Description

In order to estimate the economic impacts of changes in federal grazing rights an economic model of a representative 700 head ranch in Elko County was constructed. The study made use of a linear programming model developed in GAMS (General Algebraic Modeling System) that was originally developed by Alan Torrell and Larry Van Tassell. The program was modified to reflect current practices in ranching operations in Elko County using data collected by Curtis et al. (2005) from a panel of Elko County producers.

The linear program maximizes net returns of the representative ranch over a 40 year period, subject to constraints on land, forage and cash availability. The program allows for borrowing and saving by the proprietor as well as substitution across alternative input and output mixes in response to price and/or policy changes.³ Policy questions associated with federal grazing reductions are addressed by first running a baseline model in which the current level of federal AUMs is available. Six alternatives that include federal AUM reductions of 10%, 25%, 50%, 75%, 84%, and 100% are also analyzed. The 84% reduction is included since it represents an approximate break-even point for ranch profits across all years and iterations. Table 1 presents the available AUMs for the representative ranch in the baseline case.

Table 1: Land Base for the Elko County Representative Ranch.

Type	Amount	Productivity
Federal	4148 AUM	
Private Lease	500 AUM	
Deeded Rangeland	115 AUM	
Forage	4826 AUM	
Hay	800 acres	1.5 tons/ acre

Table 2 details the key findings from the simulation runs. In the baseline, with the full federal allotment available, an average of 3,683 AUMs or 89% of those available are used. The share increases as AUMs are restricted so that with a 50% or greater reduction nearly the entire

³ 100 iterations of the 40 year period were run with each using a price series that reflects a 12 year cycle of cattle prices. The starting point of the cycle was selected at random for each iteration in order to minimize the effect of price variability on policy impacts (Torrell et al. 2002). Prices were deflated using the most recent USDA Summary of Agricultural Prices (2006).

allotment is used under all price scenarios. Herd size (AUYs) and net cash income both fall as the AUM restriction becomes more stringent. The declines are not as severe as the AUM reductions, however, since increased use of alternative AUM sources mitigates their effects. As a result the share of federal AUMs in the total used falls from 44% in the baseline to 35% when federal AUMs are reduced by 50%. Less than proportional reductions in grazed hay and purchased alfalfa as well as small increases in purchased hay account for the greater shares of AUMs from non-federal sources.

For both the AUY and the net cash income, the severity of the negative impact increases dramatically when the restrictions grow larger than 50%. Initially, the decline in herd size occurs more rapidly than the economic returns so the net cash income per AUY is actually increasing from \$148 at the baseline and peaking at \$163 at the 50% level of reduction before falling sharply with further reductions.

In general it is true that, while the economic consequences of a loss of grazing rights are always negative, they become much more severe when the reductions exceed 50%. For example, the simulations reveal that bankruptcy is unlikely with reductions up to and including 50% percent where it reaches only a 1% probability. The probability increases dramatically however climbing to 12% and 43% with reductions of 75% and 84%, respectively. The complete elimination of federal AUMs makes bankruptcy a near certainty with a 96% probability of failure. The high level of ranch failures are associated with debt loads that increase from negligible amounts of less than \$100 for reductions less than 50% up to \$15,000 and \$65,000 for the 84% and 100% reductions.

Similarly, the probability of a loss in any year is fairly constant, between 19 to 22%, for the baseline case and reductions up to and including 50% but increases dramatically with additional AUM cuts, reaching a high of 64% for the 100% reduction in AUMs. When the probability of a loss is less than the probability of bankruptcy (64% versus 96%) the implication is that the average loss is much larger than the average gain. Thus for the 100% reduction in AUMs, we find that the average loss is -\$158,274 and the average gain \$51,446 a ratio of -3.1 to 1. The economic consequences of this result are significant for the scenarios with large AUM reductions. It implies that large fluctuations in output and profitability may precede a ranch failure, with potentially destabilizing effects on the economy in the surrounding community.

Table 3 reports additional information on gross revenues and returns as well as on

sources of revenue under the different scenarios. In addition to the figures reported in Table 3, the model assumes that the ranch generates an additional \$10,000 in off-ranch income. In the baseline, gross revenues reach \$294,000 and total costs of \$240,731 yield the ranch profits of \$53,442. Revenues are associated with the sale of 220 steer calves and 120 heifer calves as well as the sale of 263 tons of hay. Hay sales decline little with the reduction in AUMs, however revenues associated with livestock sales decline more rapidly than costs leading to 3.5%, 13.7% and 33.5% reductions for the 10%, 25%, and 50% reductions, and ultimately to the large losses associated with complete elimination of the federal AUMs.

#Table 2: Summary of Ranch Level Results for Federal AUM Reductions.

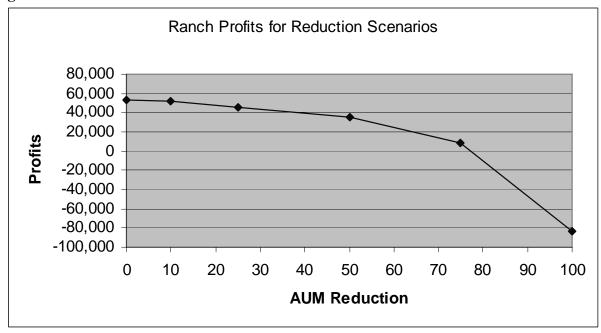
# Table 2: Summary of Kanch Level Results for Federal ACM Reductions	II ACIVI N	concentrations.					
AUM Reduction (%)	0	10	25	20	75	84	100
Federal AUMs Available	4,148	3,733	3,111	2,074	1,037	664	0
Mean AUMs Used	3,683	3,508	3,067	2,072	1,033	662	0
SD AUMs used	268	207	87	37	53	33	0
Percent of AUMs from Federal Land	44%	43%	41%	35%	24%	25%	-
Average broodcows (head)	417	405	367	311	252	237	196
SD Broodcow	28	25	26	28	38	35	62
Average number of AUYs	200	9/9	619	526	429	405	336
SDAUY	45	38	38	42	62	25	113
Average annual variable costs (\$)	190,915	185,913	172,611	145,027	132,031	127,861	185,086
SD varcost	12,424	11,516	9,725	12,376	114,458	60,611	230,179
Average annual variable costs per AUY (\$/AUY)	273	275	279	276	308	315	553
*Average annual net cash income (\$)	103,259	101,395	95,950	85,376	58,518	49,864	-33,115
SD Net	58,216	56, 158	51,331	44,259	120,896	67,423	293,246
Average annual net cash income per AUY(\$/AUY)	148	150	155	162	137	122	-98
Change in net cash income from initial fed. AUM level (%)		-1.80%	-7.08%	-17.32%	-43.33%	-51.71%	-132.07%
Deeded rangeland (AUMS)	115	115	115	115	115	115	115
SD Deed	0	0	0	0	0	0	0
Priv Lease (AUMs)	0	0	0	0	3	3	2
SD Priv Lease	0	0	0	0	35	35	31
Meadow hayland in pasture (acres)	17	13	36	137	240	290	345
SD meadow hayland pasture	33	41	65	88	96	101	148
Meadow hay fed/grazed (acres)	783	787	764	663	260	510	455
SD hay fed	33	41	65	88	96	101	148
Purchased Alf	153	148	136	115	93	88	72
SD purchalf	27	25	23	20	20	20	46
Purchased Hay	2	2	9	14	19	19	5
SD Purchased Hay	16	21	44	26	119	122	393
Average borrowings (\$)	55	28	88	358	10,322	14,593	65,490
Probability of bankruptcy (%)	0	0	0	_	12	43	96
Probability of negative profits in a single year (%)	20%	19%	19%	22%	30%	40%	64%

Prices adjusted using the most recent USDA Summary of Agricultural Prices (2006). Numbers in italics are standard deviations.

Table 2. Summary of Revenues and Returns for AUM Reduction Scenarios, Elko County

AUM						
reduction	0	10	25	50	75	100
			\$ (do	llars)		
Gross	294,174	287,309	268,561	230,403	190,550	154,144
Total Cost	240,731	235,729	222,426	194,843	181,847	234,901
Ranch Profits	53,442	51,579	46,134	35,560	8,703	-80,757
Profit decline						
(%)		3.5	13.67	33.46	83.72	251.11
Revenue sources						
Steers	220	212	194	164	134	104
Heifers	122	117	107	91	75	59
Hay (tons)	263	301	345	323	297	256

Figure 10. Mean Ranch Profits at Different AUM Reduction Levels.



Economic Importance of Public Grazing in Elko County

Federal grazing plays a large role in Elko County agricultural production. According to the 1997 Census of Agriculture, 177 ranches held grazing permits or approximately 41% of total agricultural operations in Elko County (436) in 1997 and 68% of operations with a beef cow inventory (262) in 1997. Of these ranches, 144 held grazing permits with the BLM, 61 held grazing permits with the USFS and 16 held permits with other types of land owners. Note that some owners had grazing permits with more than one type of agency.

Current data on the number of available animal unit months (AUMs) was collected from Elko County regional offices of the BLM, USFS and U.S. Fish and Wildlife Service. The data are displayed in Table 4. Total permitted AUMs in Elko County in 2006 were estimated to be approximately 847,058 with 85% of the total permitted AUMs on BLM lands and the remaining 15% on USFS land. A small amount of grazing was permitted on the Ruby Lake National Wildlife Refuge. Actual AUMs used were less than the permitted amount and vary from year to year. Another study of Elko County grazing estimated that as much as 49% of total AUMs used by the cattle industry were provided by federal grazing land (Torell et al. 1981). In addition to being a large portion of total AUMs, often the timing of forage availability on federal lands increases their importance to the ranch operation. Because of the seasonal factors, several studies have found that the value of an AUM from federal lands is greater than the value of AUMs from other sources (Torell et al. 1981; Torell et al. 2002).

Table 3. Permitted Animal Unit Months in Elko County, 2006

	Permitted AUMs
Elko and Wells District, BLM	719,680
Mountain City RD, USFS	73,101
Jarbidge RD, USFS	27,627
Ruby RD, USFS	25,937
Ruby Lake National Wildlife Refuge	713*
Total	847,058

Sources: Nevada Department of Agriculture 2003; Bureau of Land Management 2006; Prall 2006; Stefani 2006 *AUM availability varies by year from 433 to 1004. Approximately one-third of the possible grazing acreage is in White Pine County, Mackay 2006.

The results from the ranch level analysis in the previous section help to quantify the economic impacts that would result from restrictions on AUM availability on federal lands in Elko County. Because ranching operations have economic linkages with other sectors of the

county's economy, changes in federal grazing also have implications for the overall economy of Elko County. Results of the ranch level analysis suggest that there are at least two possible approaches to evaluating economic importance of federal grazing to local communities. These three approaches are 1) evaluating federal AUMs only; and 2) evaluating federal AUMs and the total effects on total production. Each of the two approaches may be appropriate in different situations depending on the individual or collective circumstances of a ranch or ranches. Factors such as dependency on federal land grazing, the magnitude of changes in grazing availability under consideration and the availability of substitutes for AUMs lost will effect which of the two approaches best reflects actual impacts on the Elko County economy.

Impact of Federal AUMs Only

UNR cooperative extension cow-calf budgets for Elko County were employed to derive a per AUM value of production of \$38 (Curtis et al. 2005). Using a modified 2003 input-output IMPLAN model for Elko County, the total economic impact of an AUM of production was estimated to be \$68 per AUM (Minnesota IMPLAN Group 2004). This represents the total economic activity that occurs within the Elko County economy as a result of an AUM of livestock production. The total economic activity generated by cattle production is greater than the direct economic activity because of the multiplier effect. A dollar earned from exports of cattle provides an injection of funds into the Elko economy. Each dollar of expenditure in the local economy creates multiple impacts as it circulates around the local economy. When a rancher buys supplies from a local feed store, a portion of that dollar is then spent to hire local employees or buy local supplies, while some of the dollar leaks outside the county. Local employees spend a portion of their salary to at local retailers and so forth. The input-output methodology estimates this multiplier effect by estimating transactions between the various sectors of the local economy and its households. The multiplier effect means that each AUM of production value generates an estimated \$13 in labor earnings and 0.00065 jobs. This represents one job for approximately 1,530 AUMs. Average earnings per job was estimated to be \$20,700 per year.

From the Federal Grazing Only Perspective, the 847,000 Elko County AUMs of federal grazing result in \$32.6 million of production, \$57.3 million in total economic activity, \$11.4 million in labor earnings, and 553 jobs in Elko County. (Table 5).

Impact of Federal Grazing on Ranch Production

Estimating the economic impact of federal grazing based solely on federal AUMs in many cases underestimates the actual importance of federal grazing. The results from the Northeastern Nevada ranch model indicate that, in terms of ranch production, one AUM of federal grazing can potentially generate as much as \$84 of livestock production. This assumes that since federal AUMs are part of an overall grazing system, a change in federal grazing affects the optimal use of the rest of the forage resources.

From the Ranch Production Perspective, the 847,000 AUMs of federal grazing could result in \$71.3 million in production, \$125.4 million in total economic activity, \$25.0 million in labor earnings, and 1,212 jobs in Elko County.

Previous research and results from the Northeastern Nevada ranch model indicate that the availability of federal land grazing is critical to the economic viability of many federal grazing dependent ranches. The ranch level analysis shows that net profits for federal grazing dependent ranches are negative without federal grazing rights. This finding is consistent with other research done in Wyoming and other areas of the Mountain West.

Table 4. Economic Impact of Federal Livestock Grazing in Elko County.

Per AUM	Federal Grazing Only	Ranch Production Perspective
Value of Production	\$38	\$84
Total Impact	\$68	\$148
Labor Earnings	\$13	\$30
Employment	0.00065	0.0014
Avg. Earnings/Job	\$20,659	\$20,659
Total AUMs	847,058	847,058
Value of Production	\$32,552,054	\$71,288,998
Total Impact	\$57,267,859	\$125,416,611
Labor Earnings	\$11,434,320	\$25,041,162
Employment	553	1,212

Economic Impact from Federal Grazing in Jarbidge and Mountain City Ranger Districts

Using the same methodology outlined above, total Elko County economic impacts associated with the USFS AUMs available in Jarbidge and the Mountain City Ranger Districts were estimated. The results are displayed in Table 6 and 7.

From Federal Grazing Only Perspective, the 27,600 Jarbidge AUMs result in \$1.1 million of production, \$1.9 million in total economic activity, \$373 thousand in labor earnings, and 18 jobs in Elko County. (Table 6). Using the ranch production perspective, total economic activity associated with cattle production using the 27,600 AUMs in Jarbidge Ranger District is \$4.1 million and results in 40 jobs.

For the Mountain City Ranger District for the federal grazing only perspective, the estimated 73,100 AUMs available on Forest Service land are associated with \$2.8 million of production, \$4.9 million in total economic activity, \$987 thousand in labor earnings, and 48 jobs in Elko County (Table 7). The ranch production perspective would imply \$10.8 million in total economic impacts and 105 jobs associated with the 73,100 AUMs.

Table 5. Economic Impact of Federal Livestock Grazing in Elko County for Jarbidge Ranger District AUMs.

<u> </u>	Federal Grazing	Ranch Production
	Only	Perspective
Total AUMs	27,627	27,627
Value of		
Production	\$1,061,693	\$2,325,108
Total Impact	\$1,867,805	\$4,090,493
Labor Earnings	\$372,933	\$816,724
Employment	18	40
Avg.		
Earnings/Job	\$20,659	\$20,659

Table 6. Economic Impact of Federal Livestock Grazing in Elko County for Mountain City Ranger District AUMs.

	Federal Grazing Only	Ranch Production Perspective
Total AUMs Value of Production Total Impact	73,101 \$2,809,238 \$4,942,209	73,101 \$6,152,232 \$10,823,438
Labor Earnings Employment	\$986,780 48	\$2,161,049 105
Avg. Earnings/Job	\$20,659	\$20,659

Summary

Federal livestock grazing is integral to cattle ranching operations in Elko County. The availability of federal lands for grazing livestock is important for individual ranches but also has an effect on the Elko County economy as a whole. Total economic impacts associated with federal land grazing in Elko County range from \$11.4 million to \$25.0 million in labor income and from 553 jobs to 1,212 jobs.

Appendix A: Elko County Beef Cattle and Sheep and Lamb Inventory Tables, 1975 to 2006

Table 7. Elko County Beef Cattle Inventory, 1975 to 2006

Year	Beef Cattle Inventory (head)		Year	Beef Cattle Inventory (head)	
	Elko Co.	Nevada	1 ear	Elko Co.	Nevada
1975	215,000	657,000	1991	160,000	520,000
1976	200,000	651,000	1992	159,000	520,000
1977	195,000	611,000	1993	147,000	500,000
1978	180,000	585,000	1994	151,000	490,000
1979	185,000	575,000	1995	157,000	500,000
1980	187,000	595,000	1996	155,000	500,000
1981	195,000	640,000	1997	166,000	520,000
1982	210,000	700,000	1998	159,000	510,000
1983	195,000	650,000	1999	164,000	510,000
1984	190,000	660,000	2000	168,000	520,000
1985	180,000	620,000	2001	170,000	520,000
1986	178,000	610,000	2002	169,000	500,000
1987	180,000	580,000	2003	162,000	510,000
1988	169,000	530,000	2004	155,000	510,000
1989	176,000	520,000	2005	150,000	500,000
1990	168,000	530,000	2006	152,000	500,000

Source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006

Table 8. Elko County Sheep and Lambs Inventory, 1975 to 2006

Year	Sheep and Lambs Inventory (head)		Year	Sheep and Lambs Inventory (head)	
	Elko Co.	Nevada	-	Elko Co.	Nevada
1975	54,000	151,000	1991	25,000	98,500
1976	51,000	153,000	1992	20,500	85,000
1977	45,000	133,000	1993	19,000	91,000
1978	32,000	125,000	1994	20,000	91,000
1979	37,000	125,000	1995	10,000	103,000
1980	34,000	122,000	1996	25,000	93,000
1981	39,000	134,000	1997	26,000	91,000
1982	40,000	129,000	1998	23,000	88,000
1983	37,000	110,000	1999	22,000	90,000
1984	34,000	103,000	2000	22,000	95,000
1985	31,000	100,000	2001	21,000	95,000
1986	22,000	81,000	2002	20,500	90,000
1987	22,000	86,000	2003	20,200	80,000
1988	19,200	96,000	2004	18,700	75,000
1989	20,000	87,000	2005	18,000	70,000
1990	25,000	101,000	2006	19,700	74,000

Source: Quick Stats, U.S. & All States County Data - Livestock, United States Department of Agriculture. National Agricultural Statistics Service 2006

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Evaluation of Three Contraceptive Approaches for Population Control of Wild Horses

Gary Killian

Almquist Research Center, Penn State University, University Park, Pennsylvania

Lowell A. Miller

USDA APHIS National Wildlife Research Center, Ft. Collins, Colorado

Nancy K. Diehl

Almquist Research Center, Penn State University, University Park, Pennsylvania

Jack Rhyan

USDA APHIS National Wildlife Research Center, Ft. Collins, Colorado

David Thain

Division of Animal Industry, Nevada Department of Agriculture, Reno, Nevada

ABSTRACT: Overpopulation of feral horses in several western states is an unquestioned problem. Current management strategies of removal and adoption are expensive, logistically challenging, and ineffective as a means of population control. We are testing three long-acting contraceptive approaches on feral Nevada mares. Modified reversible immunocontraceptive vaccines for gonadotropin releasing hormone (GnRH) and porcine zona pellucida (PZP) (SpayVac), and intrauterine contraceptive devices (IUDs), are being evaluated to determine: 1) their safety and efficacy for preventing pregnancy for multiple years, 2) whether the effects are reversible, and 3) whether there are notable contraindications. Preliminary data after 1 year suggest that IUD- and PZP-treated mares continue to exhibit breeding and estrus, while GnRH-treated mares are less likely to cycle. All mares in the GnRH and PZP treatments were infertile for the breeding season. Eighty percent of the IUD-treated mares were infertile; those mares that became pregnant likely failed to retain the IUD. A notable contraindication was that uterine edema normally observed in mares in the follicular phase of the estrous cycle was commonly observed in PZP-treated mares. Because administration of each contraceptive approach is different, and each has different effects and expected duration, one approach or a combination of approaches may be best suited for specific field applications. Subsequent years of this study should establish the efficacy and safety of one or more long-acting contraceptive approaches for feral horse population control.

KEY WORDS: contraception, feral horse, fertility control, GnRH vaccine, intrauterine device, SpayVac-PZP vaccine

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INTRODUCTION

Overpopulation of feral horses in several western states is an unquestioned problem. In Nevada, feral horses under state control number about 1,200 in an area of 360,000 acres. This represents 2 - 2.5× the number of horses suitable for that area. Feral horse populations grow at a rate of 15 - 20% a year while their range continues to shrink. Current management strategies of removal and adoption are expensive, logistically challenging, and have not been an effective means of population control. Conflicting interests associated with increased movement of people into feral horse ranges, sympathy to maintain feral horse populations because of their historic and cultural importance, competition among horses and indigenous plant and wildlife species, as well as ranching interests are issues impacted by feral horse overpopulation.

Reduction of free-ranging horse numbers by limiting fertility holds great promise for humane and effective population control. Ideally, contraception of feral horses should be safe and potentially reversible, effective for several years, and have minimal effect on reproductive or harem maintenance behavior. However, fertility control by the porcine zona pellucida (PZP) vaccine in current use has not shown consistent effectiveness for more than 1 - 2 years (Turner et al. 2002). Annual vaccination involves

much expense, manpower, and horse handling to maintain infertility and increases risks of injury to both the animals and human handlers. Use of long-acting contraceptive approaches on feral horses would achieve effective population reduction along with reduced costs and risks associated with frequent animal handling. Unfortunately, no proven options exist for long-term contraception of horses.

Immunocontraceptive vaccines are based on the principle that an animal's immune system can be used to prevent reproduction. The immunogens of these vaccines stimulate antibody production against native gamete proteins, reproductive hormones or proteins involved in early gestation. Vaccinated animals with sufficient titers form antibody-antigen complexes that interfere with or block an essential step in the reproductive process.

The most widely used and successful zona pellucida vaccines are derived from ovarian extracts of porcine zona pellucida (PZP). PZP is a complex of 4 large glycoproteins and is recognized as a foreign protein when injected into a non-porcine host. Because there is considerable amino acid sequence conservation among species for the zona pellucida, the immune response in PZP-treated animals includes antibodies that cross-react with native zona pellucida.

Injectable PZP vaccines have been used widely to induce infertility in a variety of species including deer (Turner et al. 1997), elephants (Fayer-Hosken et al. 1999), dogs (Mahi-Brown et al. 1989), baboons (Dunbar 1989), seals (Brown et al. 1997), burros, and horses (Liu et al. 1989, Kirkpatrick et al. 1996, Turner et al. 2002). Typically with a primary and booster vaccination, infertility can be achieved in 80-90% of animals for 1 year and further sustained by annual vaccination. Kirkpatrick, Turner, and colleagues have used the PZP vaccine effectively to manage reproduction in selected feral horse populations by annual vaccination (Turner et al. 2002). Their pioneering work has documented the apparent safety and reversibility of the vaccine and some physiological and behavioral responses of the mare (Kirkpatrick et al. 1996, Turner et al. 2002). These include repeated estrous cycles during the breeding season and improved body condition and increased longevity (Tuner and Kirkpatrick 2002). However, long-term treatment with PZP vaccine given annually is associated with some ovulation failure and depressed urinary estrogens (Kirkpatrick et al. 1995).

Gonadotropin releasing hormone (GnRH) stimulates the anterior pituitary gland to produce and release FSH and LH. These hormones in turn regulate gamete and hormone production by the gonads. By blocking GnRH, in either males or females, production of sex hormones and gametes ceases and treated animals enter a non-breeding condition similar to that of anestrous in seasonal breeders. Use of GnRH vaccine as a fertility blocking agent has been studied in cattle (Adams and Adams 1992), horses (Rabb et al. 1990), swine (Meloen et al. 1994), and rams (Brown et al. 1994). These studies have been of short duration, although we recently completed a long-term study using the GnRH vaccine on white-tailed deer establishing its efficacy, safety, and reversibility (Miller et al. 2000).

Extensive data for women have demonstrated that IUDs are safe and effective for long-term contraception (Fortney et al. 1999). According to "Population Reports" (Vol. XXIII, #5, December 1995), in studies evaluating the copper-containing TCu-380A IUD, fewer than 1 in 100 women became pregnant after 1 year, and 2.1 in 100 women became pregnant after 10 years of continuous use. Fertility was restored following IUD removal. IUDs have also been shown to block fertility in ewes (Hawk et al. 1974, French 1976), and cows and heifers (Hawk et al. 1968, Turin et al. 1997, Fordyce et al. 2001) in short-term The mechanism of IUD-induced infertility is speculative (Ortiz et al. 1996). Humoral factors may be released that interfere with signaling between the ovary and the uterus, blocking fertilization and early embryo development. We are aware of only one report of IUD use in mares (Daels and Hughes 1995). Six mares implanted with a silastic ring IUD remained infertile for a season, but after IUD removal all had foals the next season. Mild chronic endometritis was observed in the treated mares, but no permanent changes in the endometrium remained after IUD removal.

Based on published studies and ongoing studies we have with deer, swine, and ponies, we believe that 3 long-acting contraceptive approaches warrant study in feral

horses. These are the SpayVac PZP vaccine, a GnRH vaccine developed at the National Wildlife Research Center, and the 380 Copper "T" human intrauterine device.

The objectives of this study are to evaluate these approaches in Nevada mares for multiple-year contraceptive efficacy, whether the contraceptive effects are reversible, and whether notable contraindications are associated with the treatments. This paper reports the results from the first year of the study.

MATERIALS AND METHODS Animals

The Nevada Department of Agriculture provided 53 feral mares and 3 stallions for the project. The horses were gathered from state lands and maintained at the State of Nevada Penitentiary, Carson City facility. Mares and stallions were dewormed 3× and vaccinated annually for eastern and western encephalitis, West Nile virus, influenza, equine rhinopneumonitis, and tetanus. Nevada mares typically weigh between 225-360 kg.

To handle feral mares for jugular blood sampling and vaccinations, they were run into a hydraulic chute and haltered. Contraceptive vaccines were given intramuscularly in the left lateral neck. For pregnancy evaluations by ultrasound or palpation, or IUD placement, the mares were chemically restrained, released from the chute, and legs secured. Chemical restraint providing 20 - 30 minutes of anesthesia involved one or a combination of sedative and anesthetic agents. Initially, a combination of detomidine hydrochloride (0.02 - 0.04 mg/kg) and xylazine hydrochloride 0.8 mg/kg and acepromazine maleate (0.02 - 0.04 mg/kg) was given intravenously. After 5 - 7 minutes to allow for maximum sedation, mares were then given intravenously a combination of xylazine hydrochloride (1.2 mg/kg) and tiletamine HCL (1mg/kg) and zolazepam HCL (1mg/kg).

Treatments

Mares were randomly assigned to the following groups: untreated controls (n=8), single shot of 400µg SpayVac PZP (n=12), single-shot 1,800µg GnRH vaccine (n=15), 2,800µg GnRH vaccine (n=3), and coppercontaining IUDs (n=15). Doses of the single-shot SpayVac PZP vaccine (400µg) were kindly provided by its developer, Dr. Robert Brown (Brown et al. 1997). The single shot GnRH-AdjuVac vaccine was developed at and provided by the NWRC. Both vaccines were used in combination with AdjuVac adjuvant (Miller et al. 2003). Human Cu 380 T intrauterine devices were purchased from Family Planning Sales Limited, Littlemore, Oxford, UK

Because of the logistics of acquiring all of the mares for this study, the treatments were administered over a period of one year as the mares became available. The treatments were selected based on preliminary studies and our prior experience with them. We have determined that the single shot PZP (SpayVac) vaccine used in this study is very effective for contraception of white-tailed deer for 4 years, while others have reported long-term contraception of fallow deer (Fraker et al. 2002). We have also determined the GnRH vaccine to be effective in deer and

swine for 2 to 3 years in ongoing studies. In preliminary studies at Penn State University, we evaluated 3 different copper IUDs in pony mares. Based upon ease of placement, retention in the uterus, lack of apparent uterine inflammatory response, and pregnancy prevention (3 of 4 mares) for 24 months, the human copper "T" IUD was selected for this trial.

Nevada mares were routinely observed for breeding activity by staff and prisoner caretakers, and they were checked 2 times yearly by ultrasonographic monitoring for pregnancy, IUD retention and uterine inflammation, and blood sampled. Blood samples were assayed for estradiol, progesterone, and antibody titers to the contraceptive vaccines. Contraindications evaluated included general health and body condition, and uterine edema, which may be associated with hormonal changes or presence of IUDs.

RESULTS AND DISCUSSION

Most Nevada wild horses maintained at the Carson City facility were possible to work with and collect data. However, on some dates we were unable to collect data from certain individuals, because of inadequate anesthesia and/or safety concerns.

After one breeding season involving study mares being with a proven stallion for at least 60 days, none of the mares in the PZP-SpayVac (0/12 mares) or GnRH (0/18) vaccine groups were pregnant as evaluated by ultrasonography (Figure 1). For the IUD mares, 20% became pregnant (3/15). This compares with 75% of the control mares (6/8) becoming pregnant. These results clearly indicate that both contraceptive vaccines were highly effective in preventing pregnancy. somewhat less effective, the IUD treatment was also considered successful in preventing pregnancy in a high percentage of mares. Based on our inability to observe the IUD in pregnant mares, a tentative conclusion is that the pregnant individuals in the IUD treatment failed to retain their IUDs. This may have occurred because the human 380 copper "T" used in this study is quite small (about 1" long) and may have been more easily expelled from the mare uterus than the human uterus for which it was designed. We are currently testing larger coppercontaining IUDs to determine if retention is improved.

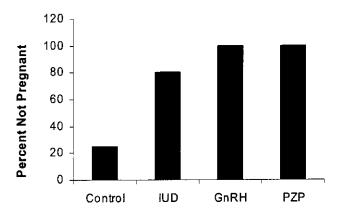


Figure 1. Percentage of mares not pregnant for each treatment group, based on ultrasonography.

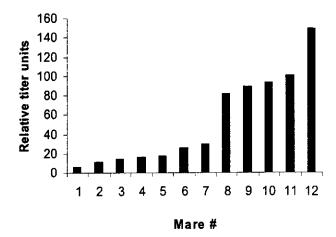


Figure 2. Relative antibody titers of individual mares (# 1-12) generated in response to the 400μg SpayVac-PZP vaccine, 7 months post-immunization.

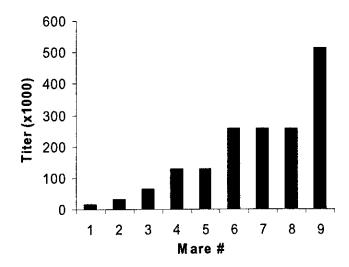


Figure 3a. Antibody titers of individual mares (#1-9) generated in response to the 1800μg GnRH vaccine, 7 months post-immunization.

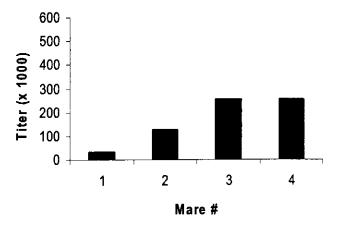


Figure 3b. Antibody titers of individual mares (#1-4) generated in response to the 2800 μ g GnRH vaccine, 7 months post-immunization.

Individual antibody titers for the SpayVac-PZP vaccine indicate a wide range of titers among individuals receiving the single 400µg dose (Figure 2). Seven of the individuals had titers one-third or less than the 5 mares with the highest titers. Nevertheless, all of the titers were adequate to impart contraception for the breeding season. For the GnRH mares receiving the 1,800µg dose, a range of titer responses was also evident (Figure 3a) but somewhat less diverse than that seen for the PZP mares (Figure 2.) The three mares receiving the 2,800µg did not produce titers that were greater than mares receiving the lower dose (Figure 3b), and all GnRH vaccine-treated mares were infertile. Future years of study on all vaccinated mares may provide evidence that higher titers are associated with a longer lasting contraceptive effect, but for now this remains speculative.

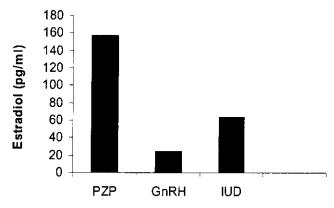


Figure 4a. Serum estradiol concentrations determined in November 2003 when mares were evaluated by ultrasonography for pregnancy.

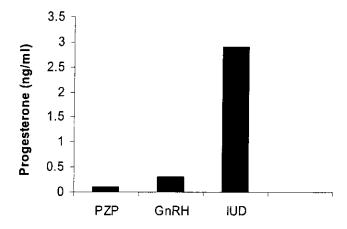


Figure 4b. Serum progesterone concentrations determined in November 2003 when mares were evaluated by ultrasonography for pregnancy.

An intriguing aspect of this study is related to the average estradiol (Figure 4a) and progesterone (Figure 4b) serum concentrations determined for each of the treatment groups. Average values determined from a single sampling of a population can provide some

insights into whether animals within the population are experiencing estrous cycles. The typical mare estrous cycle is 22 days long (Ginther 1992). During 4 - 6 days of the cycle mares are in the follicular phase, during which estrogen secretions associated with follicular development increase and behavioral estrus occurs. During the remaining 16 - 18 days of the cycle, progesterone secretions are predominant. Therefore, for a randomly-sampled population of cycling mares, one would predict serum progesterone to be elevated and estradiol to be lower in 75 - 80% of the mares. However, for the PZP-treated mares, average serum estrogen was elevated in the majority of mares (Figure 4a) and serum progesterone was negligible (Figure 4b). These observations suggest that PZP-treated mares may not cycle normally and may fail to develop a functional, progesterone-secreting corpus luteum. An alternative explanation may be that the estrous cycles of the mares in the PZP group were synchronized and in estrus at the time of sampling, although there are no data to support this conclusion. In contrast to the PZPtreated mares, GnRH-treated mares had low serum concentrations of both estrogen and progesterone (Figure 4a and 4b), which is in accord with the predicted effect of the vaccine to immunologically castrate treated individuals (Miller et al. 2003).

Mares with IUDs had elevated average serum progesterone and somewhat elevated serum estrogen (Figure 4a. and 4b.), suggesting that the majority of mares within the IUD treatment are cycling. Unfortunately, we do not have average serum estrogen and progesterone concentrations for a group of control mares that were cycling and not pregnant to use for comparison. Seventy-five percent of the control mares in this study were pregnant.

There was no indication of adverse treatment effects on body condition and general health of the mares on the study. Ultrasonography of the uterus did not reveal evidence of uterine infection or fluid accumulation associated with the presence of the IUD. Uterine edema, typical of mares in estrus, was evident in ultrasonograms (Table 1). For cycling mares in a typical population, we would predict that ~25% of the females to be in the follicular phase based on an average cycle length of 22 days, and 4 - 6 of those days in the follicular phase. It is notable that we observed uterine edema in ~25% the mares in the IUD and GnRH treatments, as predicted. However, 82% of the PZP-treated mares showed evidence of uterine edema (Table 1). These findings support the serum steroid observations showing estrogen as the dominant serum hormone in PZP-treated mares (Figure

In conclusion, results of the first year of study indicated that both vaccines and the IUD contraceptive approaches are successful in preventing pregnancy in a high percentage of mares. Establishing the long-term efficacy and potential contraindications of these approaches, to be determined in future years of study, will be critical to establishing the utility of these approaches for population control of wild horses.

Table 1. Percentage of reproductive tracts with edema revealed by ultrasonography in mares for each of the
treatments compared to the predicted number of mares expected to be in estrus.

Treatment	Total # Ultrasounds	Predicted Tracts in Estrus (25%)	Observed Tracts Edema	Percent with Edema
PZP	11	2.8	9	82
GnRH	13	3.3	3	23
IUD	10	2.5	2	20

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Long-term Efficacy of Three Contraceptive Approaches for Population Control of Wild Horses

Gary Killian, Nancy K. Diehl

J. O. Almquist Research Center, The Pennsylvania State University, University Park, PA

Lowell Miller, Jack Rhyan

National Wildlife Research Center, USDA-APHIS, Ft. Collins, CO,

David Thain

Division of Animal Industry, Nevada Department of Agriculture, Reno, NV.

Corresponding author:

Gary Killian, Ph.D.

Almquist Research Center

Penn State University

University Park, PA 16802 USA

814 865-5894

Email: gkillian@psu.edu

Abstract:

Controlling fertility of feral horses through the use of long-acting contraceptives or sterilization approaches has been championed as a reasonable and humane solution for addressing overpopulation problems in several western states. However, methods to accomplish long-term contraceptive efficacy of horses following a single treatment have been lacking. In the fall of 2002 and the spring of 2003 we initiated a study to compare the long-term efficacy of a singleshot contraceptive vaccine directed at gonadotropin releasing hormone (GonaConTM) with that of a single-shot vaccine directed at the zona pellucida (SpayVac) with the use of intrauterine contraceptive devices (IUD). Both vaccines were administered with AdjuVacTM, an adjuvant developed at the National Wildlife Research Center. The objectives of the study were to determine 1. three year efficacy for preventing pregnancy, 2. whether the contraceptive effects are reversible, and 3. whether there are contraindications. The Nevada Department of Agriculture provided the feral mares which were maintained at the Nevada State Penitentiary, Carson City facility. Mares were dewormed and given health vaccinations annually. Eight untreated control mares were compared to 12 mares treated with SpayVac, 16 mares treated with GonaConTM and 15 mares treated with copper-containing IUDs. All mares in the SpayVac group were infertile and 94% (15/16) were infertile in the GonaConTM group during the first breeding season. In year two, 80% of the SpayVac-treated mares (10/12) and 60% (9/15) of the GonaConTM -treated mares were infertile. In year three, 80% of the PZP mares and 53% (8/15) of the GonaConTM -treated mares were infertile. For IUD-treated mares 80% (12/15) were infertile after year one, but only 29% (4/14) and 14% (2/14) were infertile after years two and three. For mares given SpayVac, uterine edema was commonly observed. In years two and three, antibody titers for SpayVac were progressively lower compared to titers observed in year one.

Key Words: contraception, feral horse, GnRH vaccine, intrauterine device, SpayVac-PZP vaccine

INTRODUCTION

Contraception of wildlife and feral species has been considered a desirable option for addressing concerns of over population for many years. Ideally, the contraceptive approach should be easily administered, be effective for multiple years and have little or no contraindications in the target species. Immuncontraceptive vaccines are believed to fulfill many of the attributes desired for population control. Data reported previously for several species including horses support to the notion that immunocontraceptive vaccines are safe and effective in the short term (reviewed in Killian, et al., 2004). One injectable immunocontraceptive vaccine that has been extensively researched for use in wildlife and feral species is the porcine zona pellucida (PZP) vaccine. This vaccine presumably works by stimulating antibody production against the zona pellucida, the non-cellular outer covering of the egg. Consequently, the normal interaction between sperm and egg is prevented by the presence of antibodies on the surface of the ovum. One of the short comings of most formulations of PZP vaccines previously reported however, is that a single vaccination is effective for only 1-2 years at most (Fagerstone et al. 2002). Although less extensively evaluated than the PZP vaccine for wildlife contraception, the gonadotropin releasing hormone (GnRH) vaccine is also of interest as an immunocontraceptive approach, since it provides a means of non-surgical castration by compromising reproductive hormone and gamete production of both males and females.

Considering the needs of population control of western, free ranging mustangs, annual

vaccination by injection is not a practical means to maintain infertility. Annual capture is inefficient, costly and involves added risks of injury to horses and handlers. Although oral forms of contraceptive vaccines may make it practical to annually vaccinate free roaming species with minimal difficulty, they are not now available and their development will probably take many years. Given the status quo, it was our belief that if the PZP and GnRH vaccines were modified or shown to act longer, they would eliminate the need for annual vaccination and provide a reasonable short-tem solution for controlling fertility in wild mustang populations.

In the fall of 2002 and the spring of 2003 we initiated a study to compare the long-term efficacy of a single-shot contraceptive vaccine directed at gonadotropin releasing hormone (GonaConTM) with that of a single-shot vaccine directed at the zona pellucida of the ovum (SpayVac). Both vaccines were administered AdjuVacTM, an adjuvant developed at the National Wildlife Research Center. In addition, we evaluated the use of an intrauterine contraceptive device (IUD), the 380 copper "T" since in humans it has been shown to be effect for maintain infertility for up to 12 years (Killian et. al., 2004).

The objectives of the study for these contraceptive approaches were to determine: 1. rates of contraception for up to three years, 2.whether the contraceptive effects were reversible and 3. whether there were contraindications. We now report the results following three years of study.

MATERIALS AND METHODS

The details pertaining to the horses used in the study and the treatments they received were previously reported (Killian, et al., 2004). They are briefly summarized below.

Animals

The Nevada Department of Agriculture provided 53 mares and 3 stallions for use in the

project. The mares weighed 225-360 kg and ranged in age from 18 months to 12 years at treatment. The horses were previously gathered from state lands and brought to the Nevada State Penitentiary, Carson City facility, where the study was conducted. All horses were given annual health vaccinations and dewormed routinely.

To handle feral mares for jugular blood sampling and vaccinations, they were run into a hydraulic chute and haltered. Contraceptive vaccines were given intramuscularly in the left lateral neck. For pregnancy evaluations by ultrasound or palpation, or IUD placement, the mares were chemically restrained.

Treatments

The studies were approved by the Institutional Animal Care and Use Committee of the Pennsylvania State University. Eight mares were assigned to be untreated controls, twelve mares received a single shot of 400μg SpayVac PZP, fifteen mares received a single-shot 1800μg of GonaConTM vaccine and three mares received 2800μg GonaConTM vaccine. Fifteen mares received copper-containing IUDs placed into the uterus, trans-cervically. Doses of the SpayVac PZP vaccine were kindly provided by the vaccine's developer, Dr. Robert Brown (Brown et al., 1997). The single shot GonaConTM vaccine was developed at and provided by the NWRC. Both SpayVac and GonaConTM were used in combination with AdjuVacTM adjuvant (Miller et al., 2004). The human Cu 380 T intrauterine devices were purchased from Family Planning Sales Limited, Littlemore, Oxford, UK.

Observations

Nevada mares were routinely observed for breeding activity by staff and prisoner caretakers, and checked 1-2X yearly by ultrasonographic monitoring for pregnancy, IUD

retention and uterine inflammation. Blood samples were assayed for estradiol, progesterone and antibody titers to the contraceptive vaccines at the NWRC (Miller et al. 2000, 2001). Contraindications evaluated included general health and body condition, uterine edema, which may be associated with hormonal changes or presence of IUDs. One mare receiving the GonaConTM vaccine died after the first breeding season of causes not related to the treatment.

RESULTS AND DISCUSSION

Contraceptive efficacy:

All mares in the SpayVac group were infertile and 94% (15 /16) were infertile in the GonaConTM group during the first breeding season (Fig. 1). In year two, 80% of the SpayVactreated mares (10/12) and 60% (9/15) of the GonaConTM -treated mares were infertile. In year three, 80% (10/12) of the PZP mares and 53% (8/15) of the GonaConTM -treated mares were infertile. For IUD-treated mares 80% (12/15) were infertile after year 1, but only 25% and 14% were infertile and after years two and three.

SpayVac

Mares receiving a single vaccination of SpayVac maintained a high level of contraception throughout the three year study. This rate of efficacy exceeds any previously reported rate for use of PZP vaccines in mustang mares or burros (Liu et al. 1989, Kirkpatrck et al., 1996, Turner et al., 2002a). In previous studies with mares given a primary and booster vaccination, infertility was achieved in 80-90% of animals for 1 year, and further sustained at this level by annual vaccination. Although Kirkpatrick, Turner and colleagues have used annual vaccination with a

PZP vaccine to effectively manage reproduction in some feral horse populations (Turner et al., 2002), annual recapture and vaccination of mares is not a practical approach for most field applications.

Various preparations of injectable PZP vaccines have been used for contraception of a long list of species (Fagerstone, et al, 2002), including deer (Turner et al. 1997, Miller et al. 2001, Fraker, et al. 2002), elephants (Fayer-Hosken et al., 1999), dogs (Mahi-Brown et al. 1989), baboons (Dunbar, 1989) and seals (Brown et al. 1997). However, the only formulation of single-shot PZP vaccine that appears to consistently produce a high degree of contraception lasting multiple years is the form developed by Dr. Robert Brown known as SpayVac. Our findings confirm, in a controlled study, the multi-year efficacy for mares that has been reported for harbor seals ((Brown et al. 1997) and fallow deer (Fraker, 2002) using this formulation of PZP vaccine.

We observed that SpayVac-treated mares were more likely to have elevated serum concentrations of estradiol and show evidence of estrus at sampling than GonCon- or IUD-treated mares. These observations were correlated with a high incidence of uterine edema (>80%) in PZP-treated mares (Table 1.) Uterine edema associated with estrus would normally be expected to be seen in ~25% of a population of randomly sampled mares during the breeding season. This prediction is based on the assumption that the normal mare estrous cycle is 22-24 days, and for approximately 6 days or 25% of that cycle she will be in estrus. From our observations it is evident that uterine edema was present in a much higher percentage of PZP-treated mares than predicted. Although repeated estrous cycles during the breeding season have been reported for PZP-treated mares (Tuner and Kirkpatrick, 2002a) it was generally concluded that the repeated estrous cycles were of normal length. However, we suggest that the high incidence of uterine edema and behavioral estrus observed for the Nevada mares during

sampling in this study indicates abnormal estrous cycles. These abnormal estrous cycles are likely characterized by a prolonged follicular phase and brief, if not absent, luteal phase. To better characterize the estrous cycle of mares treated with the PZP vaccine it would be necessary to draw daily blood samples for hormone assay. Unfortunately, mustangs do not lend themselves to frequent handling regimens. Such studies would need to be done on domestic mares.

GonaConTM

The single-shot GonaConTM vaccine performed quite well during the first year, but the contraception rate decreased to 60% in year two and 53% in year three. Although GonaConTM did not perform as well as SpayVac, the multi-year results achieved with a single vaccination of GonaConTM far exceed published results for contraception studies with wild horses using PZP vaccines (Turner et al. 2002a, Kirkpatrick and Turner, 2002). In addition, mares did not display evidence of frequent estrus, or abnormally high incidence of uterine edema. It is noteworthy that the drop in contraception rate was greatest between years one and two with only minimal decrease from year two to year three (Fig 1). A similar trend was seen with SpayVac, although to a lesser degree. This suggests that considering the immunological response, there are two subpopulations of mares. One population responded with antibody titers adequate for contraception that were maintained over several years, versus the other population that lasted no more than one year. Given the limited data we were able to collect from mustang mares, it is not possible provide an explanation for the immunological differences between the multi-year and single-year responders.

Vaccine antibody titers:

Contraceptive efficacy of both SpayVac and GonaConTM was clearly related to antibody titer (Figs. 2 and 3). Average titers for contracepted mares in each of the three years of study were considerably greater than those mares which became pregnant. The average titer for contracepted mares receiving SpayVac progressively declined during each year of study. However, the average titer in year 3 for contracepted SpayVac mares was still nearly 8-fold greater than the average "breakthrough" titer for all SpayVac-treated mares that became pregnant. There was a 37% decline in titer between year 1 and 2 and a 33% decline between years 2 and 3. If we assume an average annual rate of decline in titer of 35%, this suggests that on average, the majority of SpayVac-treated mares will remain contracepted for four additional years before the breakthrough titer is reached. This projection of a total of 7 years of contraception for SpayVac-treated mares is supported by the literature report of long-term efficacy of SpayVac use in Grey seals (Brown et al., 1997).

Average titers for contracepted GonaCon-treated mares did not show the same rate of decline in annual titer as seen with SpayVac. However, this observation is somewhat misleading since in year 2, 40% of the GonaCon-treated mares became pregnant. The lower titers for these mares were averaged in the pregnant group, favoring a higher average titer for the mares in the GonaConTM contracepted group. The fact that pregnant mares with lower titers were no longer included in the contracepted group explains the small artifactual rise in titer in year 2. The 15% decline in GonaConTM titer for the contracepted mares between years 2 and 3, may more accurately reflect the annual rate of titer decline to expect for GonaCon-treated mares following a single injection. The average titer for the 8 remaining GonaCon-treated mares contracepted in year 3 was 132 x 10³ or nearly 3-fold greater than the 45 x 10³ titer for the 5 mares that became pregnant. However, one of the mares that became pregnant had a titer of 128 x 10³ while the

average for the other 4 was only 24×10^3 . This emphasizes the individual variability that can occur relative to titers and efficacy of a contraceptive vaccine.

IUDs

Although the 380 Copper "T" IUD performed respectably during the first year of study with an 80% contraception rate (Fig. 1), its performance as a contraceptive was poor during years two and three. Because we were not able to visualize the IUD by ultrasonography in mares that were <50days pregnant in years two and three, we believe that the IUD was expelled from the reproductive tract. Daels and Hughes (1995) reported that six domestic mares implanted with a silastic ring IUD were infertile for one on breeding season and all mares returned to fertility after IUD removal the following breeding season. In unpublished studies we are conducting using the 380 copper "T" in domestic pony mares, several mares have remained contracepted for 3-4 years. Given the difference in uterine size between the pony and mustang mare, it is likely that the human 380 cooper "T" is too small to be consistently retained in the uterus of the mustang mare. Retention of foreign objects in the uterus of the mare is clearly related to the size of the object. In studies using glass balls inserted into the uterus of mares to suppress estrous behavior, it was indicated that the size of the glass ball influenced its ability to be retained by the mare (Nie et al., 2001; Thomas, 2002). Although the human 380 Cu "T" did not perform for multiple years as we expected based on studies with humans, further research to develop an IUD better suited to mustang mares could produce an effective means of long-term contraception.

Contraindications

We found no significant contraindications that would affect the well-being of mares given any of the treatments. All mares were in good body condition throughout the study. The

presence of the copper containing human IUD in the uterine lumen, did not appear to cause a uterine inflammatory response as reported for domestic mares equipped with sialstic IUDs (Daels and Hughes, 1995).

While a high incidence of uterine edema was observed in SpayVac-treated mares which, may have been due to irregularities in the estrous cycle, there was no indication that this naturally occurring response to estrogen adversely affected the mares. There was no pattern of elevated estradiol or reduced progesterone in SpayVac-treated mares compared to GonaCon- or IUD- treated mares. However, given the limited blood sampling we were able to do it is not surprising. Frequent blood sampling is necessary to accurately characterize hormonal changes during the estrous cycle, a study better pursued with domestic mares.

Our results with the PZP vaccine agree with the report and general conclusion that mares treated with the PZP vaccine do not suffer from ill effects (Kirkpatrick et al., 1995; Turner and Kirkpatrick, 2002b). This conclusion is also supported by our study in white-tailed deer treated with PZP vaccine that there were no significant adverse health effects (Miller et al. 2001). We also came to the same conclusion for white-tailed deer treated with GonaConTM, evaluated in a target safety study, which is reported in a companion paper at this meeting (Killian et al. 2006).

Conclusions

Three years of study on mustang mares treated with immunocontraceptive vaccines and an IUD suggest that they are safe and effective. Multiyear contraceptive efficacy was greatest for SpayVac, followed by GonaConTM and the IUD. Given the number of mares becoming pregnant in years 2 and 3 we conclude that the IUD and GonaConTM approaches are reversible. Further study is needed to establish the rate of reversibility for the SpayVac vaccine although the

reversibility of other PZP immunocontraceptive vaccines has been reported (Kirkpatrick and Turner, 2002).

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Table 1. Percentage of reproductive tracts with edema revealed by ultrasonography of mares for each of the treatments compared to the predicted number of mares expected to be in estrus.

	Year 1	Year 2	Year 3
Predicted %	25%	25%	25%
GonCon Actual %	23% (3/13)	25% (2/8)	25% (2/8)
SpayVac Actual %	82% (9/11)	91% (10/11)	100 % (10/10)

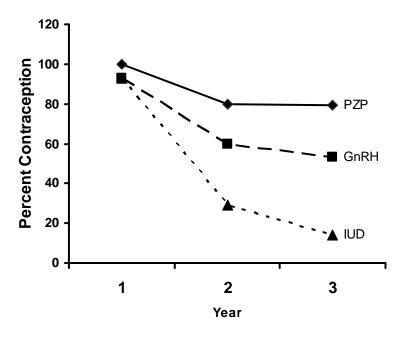


Figure 1. Percent mares contracepted in years following treatment with SpayVac (PZP), GonaConTM (GnRH) or the 380 copper "T" human intrauterine device (IUD).

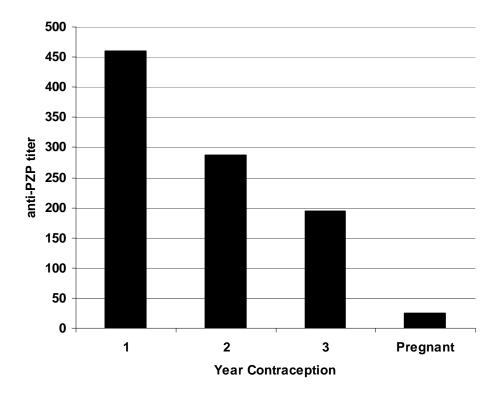


Figure 2. Average antibody titers for contracepted mares treated with SpayVac in years following treatment compared to the average titer of all pregnant mares.

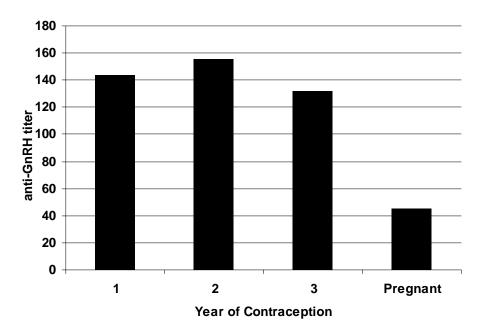


Figure 3. Average antibody titers for contracepted mares treated with GonaConTM in years following treatment compared to the average titer of all pregnant mares.

Trich in Nevada

David Thain, DVM, University of Nevada, Reno, Extension Veterinarian Ben Bruce, PhD, University of Nevada, Reno Extension Livestock Specialist Ron Torell, University of Nevada Cooperative Extension Livestock Specialist

<u>Trichomoniasis</u> (as this author learned in veterinary school) or <u>Trichomonosis</u> as is often times used today are both used to refer to the reproductive cattle disease "Trich". The increased awareness and problems associated with this disease have led to an industry request to the Nevada Department of Agriculture to institute regulations for the control of trich. This is the first of a three part series about trich in Nevada.

The Disease

Trich is a venereal disease of cows and heifers caused by a protozoon called Tritrichomonas foetus. This organism can live in the lining of the penis and the prepuce (the sheath around the penis) of the bull and does not appear to cause any disease or problems with the bull's semen or reproductive tract. Most experts agree that once a bull becomes infected with trich, he is infected for life. Currently there is no effective treatment for bulls with this disease. During breeding the bull infects cows and heifers with the organism which leads to reproductive disease in the cow and heifer. Newly infected female cattle will usually abort or resorb the fetus at 6 to 8 weeks after conception. Many of these animals will over time develop immunity, clear the infection and rebreed. Newly infected herds with a bull turnout of less than 90 days may experience a 50-60 % or less calf crop. Where the bulls are left out for a longer period of time, herds will have a long calving interval but more calves. Chronically infected herds may have a higher calving rate over an extended calving interval (sometimes referred to as year round calving). The majority of cows will clear the infection from their reproductive tracts. Some cows will not be able to clear the infection and will not be able to rebreed. Many of these develop pyometra a condition characterized by a pus filled uterus. Less than 1% of infected cows will have a normal pregnancy and still be infected with the trichomonas organism for the next breeding season. Other means of disease transmission are theoretically possible: contaminated semen and insemination equipment and bull to bull transmission. But these are rare events here in Nevada. The usual means is an infected bull exposing unexposed cows or infected cows exposing uninfected bulls. Common allotments and adjacent allotments with commingling are two high risk situations that commonly lead to new herds becoming infected.

Diagnosis

Diagnosis of Trichomonosis in cattle is less than ideal. The test in infected bulls is about 80% effective. This mean that if there are 100 infected bulls tested only 80% of the tests will be positive. The test should be performed after a minimum of two weeks of sexual rest. The procedure involves scraping the inside of the prepuce with a pipette. Next this material is introduced into a commercial media for culture called an "InPouch TF". The pouch is incubated for several days and examined daily under the microscope by trained veterinarians or technicians for trichonomads. Approximately 5% of positive samples in

Nevada are false positives. These false positive are really trichomonad species from fecal contamination. To accurately differentiate these two different species require the use of a specialized DNA test known as a PCR test. This requires an advanced laboratory like the Reno Animal Disease and Food Safety Laboratory. A single round of tests in a bull battery without any history of infertility is very accurate in determining the presence of trich in the herd. However to adequately determine if a bull from an infected herd is not infected with trich requires 3 consecutive tests at least a week apart. Back to the example of 100 infective bulls, after the first test we have identified 80 bulls. If we then retest the 20 negative bulls a second time we should find another 16 bulls (20 X 80% = 16). If we retest the 4 negative bulls we should find 3 more infected bulls, giving a grand total of 99 positive bulls. The diagnosis of trich in cows is even more difficult because the cow has usually cleared the infection by the time a problem has been identified. Testing of the mucus from the cow's vagina or cervix or pus from a pyometra may lead to a diagnosis, but this is not a reliable means of diagnosis. The best means of testing a herd for the presence of trich is to test all of the bulls.

Treatment

Unfortunately there is no approved, effective treatment for Trichomonosis in cows or bulls at this time.

Prevention, Control, and Management The uninfected herd

Annually test all bulls including virgin bulls added to the bull battery. The bull battery ideally should be tested two weeks after the end of the breeding season, with new additions tested during semen testing before turnout. Buy only virgin heifers from a known source. Efforts should be made to prevent commingling of adjacent herds. In common allotment situations, all producers should regularly test all bulls annually. There is a commercial trich vaccine manufactured by Fort Dodge (TrichGuard and TrichGuard V5L). This vaccine does not prevent infections, but will reduce the incidence of abortion associated with trich in cows. The vaccine has no proven efficacy in bulls. The vaccine must be given twice 2-4 weeks apart and with an annual booster 4 weeks before breeding season. Most experts agree that vaccinating in the fall for spring breeding is not effective. A paper was published in 2004 addressing reducing risks associated with trich in beef cattle, the conclusion is: "Highest calving incidence is achieved when all bulls are tested for T. foetus before the breeding season and all bulls with positive culture results are culled. Avoiding all risk factors is better than vaccinating, but when this is not feasible for a given herd, the results of this simulation indicate that proper vaccination can decrease economic losses attributable to abortions caused by T. foetus. (American Journal of Veterinary Research 65: 770-775)"

The infected herd

Test all bulls two weeks after the end of the breeding season. If any bulls are positive, retest the negative bulls two more times at least a week apart. Send all positive bulls to slaughter. Sending the positive bulls to the sale yard where another producer may buy them only insures perpetuating the disease.

Pregnancy test all cows and cull open and late cows. Cows found to be open at calving or observed to abort before calving should also be culled before bull turnout, because they may be infected with trich. Institute the other measures used in the uninfected herd listed above.

Consider working with neighbors to insure they are also instituting these measures. Vaccination may be a consideration to minimize the effects of trich. Consult your herd veterinarian.

Conclusion

Trichomonosis is a venereal disease that may cause catastrophic calf crop failures. There is no treatment for infected bulls or cows. There is no perfect vaccine. A producer should build a relationship with a veterinarian to develop an overall herd health program that addresses trich as well as other reproductive diseases.

Next month: What are other state's regulations and how effective these regulations are in controlling trichomonosis. If you would like to discuss this topic, do not hesitate to contact David Thain at 775-784-1377 or dthain@cabnr.unr.edu.

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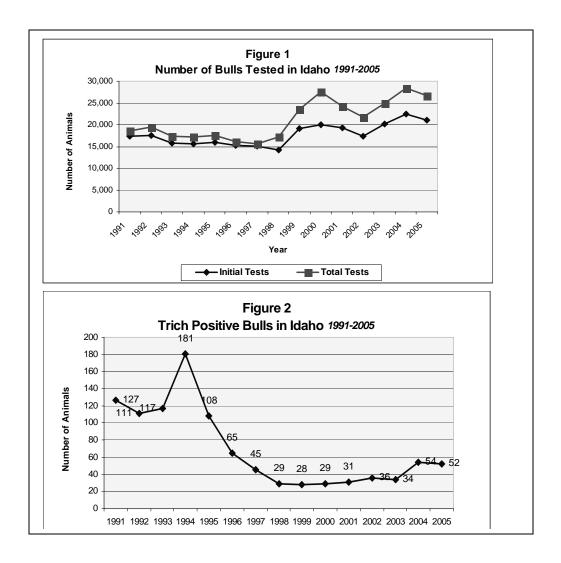
Trich in Nevada What Other States Are Doing

David Thain, DVM, University of Nevada, Reno, Extension Veterinarian Ben Bruce, PhD, University of Nevada, Reno Extension Livestock Specialist Ron Torell, University of Nevada Cooperative Extension Livestock Specialist

This is the second of a three part series discussing the cattle venereal disease trichomonosis. Last month the discussion revolved around trichomonosis as a potential threat to a producer's calf crop. This month we will discuss other state regulations and their effectiveness in controlling trich as well as Nevada's proposed regulations. As last month's article discussed, there is no treatment for trich, nor is there a good diagnostic test for cows and the test in bulls is less than desirable. Because of these issues most state's regulations are directed at controlling trich and not at eradication.

Idaho

According to Idaho regulations (IDAPA 02.04.03, Rules Governing Animal Industry), trichomonosis (Trich) testing is an annual requirement, with the testing year beginning September 1 and running through August 31. All testing must be completed by April 15th of the testing year. Trich testing is required for all breeding bulls in the state of Idaho, with the exception of dry-lot dairy bulls, south of the Salmon River. Bulls north of the Salmon River are exempt from the Trich testing requirements. Idaho developed these regulations in the early 90's at the request of the livestock industry. During Bob Hillman's tenure as Idaho State Veterinarian, he made the comment that this was the most widely supported regulation of the State Veterinarian's office. When a bull is found to be positive it must go to slaughter. Other herd bulls from the same operation must have a total of three negative tests before they may be used for breeding. Figure 1 shows the number of tests performed since 1991 and figure 2 shows the number of positive bulls found each year. The incidence of trich in bulls has declined, but the disease is still present.



Utah

According to Utah regulations (R58-21-3. Trichomoniasis - Rules - Prevention and Control), All bulls nine months of age and older residing in Utah, and all commuter bulls must be tested with an official test for trichomoniasis annually, between October 1 and May 31 of the following year, and prior to exposure to female cattle. As was the case in Idaho, the livestock industry requested implementation of these regulations. Utah began the program in 1997. Figure 3 shows the results for testing in 1997 and 2005. According to Dr. Rogers, Utah Assistant State Veterinarian: "The incidence of Trichomoniasis has fallen in Utah from an estimated 5% in 1999 to 0.3% in 2005". The value of this program, illustrated figure 4, assumes that each infected bull will fail to settle 20 cows and each unborn calf is worth \$450 and is calculated to benefit the Industry in the amount of \$6,766,000 in 2005.

Figure 3 Test Results from Utah 1997 vs. 2005					
	Bulls				
Year	tested	Positives	% incidence		
1997			5%		
See note	5000	160	estimated		
2005	17000	50	0.35%		

Note: The 1997 incidence of trich was estimated to be 5%

Figure 4	1997	2005
Utah financial cost for Trich 1997 & 2005	5% infection rate	.3% infection rate
Number of bulls	17,000	17,000
Incidence of Trichomoniasis	0.05	0.003
Number of positive bulls	851	51
Open cows per positive bull	20	20
Number of unborn calves	17,000	1,020
Value of each calf	\$450	\$450
Loss due to Trichomoniasis	-\$7,650,000	\$-459,000
Cost of testing @\$25/bull		\$-425,000
Cost of trich program		\$-884,000
Benefit to the Industry created by the program		\$6,766,000

South Dakota

According to South Dakota regulations adopted in June 2005 (12:68:27:03. Intrastate trichomoniasis testing requirements for bulls & 12:68:27:04. Trichomoniasis control requirements for females), operations adjacent to or exposed to an infected herd shall be quarantined until all bulls are tested for trich and no nonvirgin and nonpregnant female cattle may be imported, loaned, leased, nor acquired for breeding purposes in South Dakota. However, nonvirgin and nonpregnant female cattle registered with a breed registry, or to be used in confined dairy operations, may be exempt from the provisions of this section as determined by the board. Nonvirgin and nonpregnant female cattle, each accompanied by its own offspring and prior to rebreeding are exempt from the provisions of this section. These regulations not only address infected bulls, but also attempt to deal with potentially infected female cattle. Since adoption, only two herds have been found to be infected (both herds were previously infected). No herds have been identified in 2006. These regulations are an attempt at eradicating the disease from South Dakota.

Nevada

The Nevada livestock industry requested regulations to control trich in Nevada. Accordingly the following Nevada Department of Agriculture Regulations under review by the Board of Agriculture, would be put in place: Testing requirements for all bulls

entering Nevada (including commuter health/pasture to pasture) over 8 months of age except feedlot, rodeo or exhibition bulls. Only accredited NV licensed vets may Trich test and all bulls tested must have an approved individual color-coded Trich eartag. Positive tests are reportable to the owner and the State Veterinarian. The State Veterinarian will contact adjacent neighbors and advise of the positive test and make an epidemiological investigation to determine whether exposure has occurred. If determined to be exposed, adjacent premises shall have a hold order placed on the operation & must have all bulls Trich tested within 12 months. The State Veterinarian will quarantine infected herds until negative tests clear exposed bulls (3 negative tests). Premises must complete all Trich testing within 12 months or send exposed bulls to slaughter. All bulls over 8 months of age offered for sale for breeding purposes must be trich tested, all non-tested bulls may be sold for slaughter only. Estray or commingled bulls may be required to be trich tested at the bull owner's expense. Premises under a hold order or quarantine may not sell bulls, cows and heifers over twenty (20) months of age except into slaughter channels until testing is complete.

Conclusion

Idaho and Utah have had a great deal of success in controlling trich, but have been unable to eradicate the disease. South Dakota has instituted some very onerous regulations in an attempt to eradicate trich and only time will tell if these rules are effective. Nevada's proposed regulations were formulated to address the disease situation found in Nevada and are directed at controlling the disease. The authors would like to thank the State Veterinarian's offices of Idaho, South Dakota and Utah for the information included in the article.

Next month: What are the trichomonosis financial impacts of the disease here in Nevada and the results of a survey of Nevada producers about trich. If you would like to discuss this topic, do not hesitate to contact David Thain at 775-784-1377 or dthain@cabnr.unr.edu.

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Trich in Nevada Producer's concerns and the financial impact

David Thain, DVM, University of Nevada, Reno, Extension Veterinarian Ben Bruce, PhD, University of Nevada, Reno Extension Livestock Specialist Ron Torell, University of Nevada Cooperative Extension Livestock Specialist Willie Riggs, University of Nevada Cooperative Extension Educator Eureka Nevada

The past two articles have discussed the cattle venereal disease trichomonosis (trich) and what other states are doing to control the disease in their cattle populations. This month we would like to discuss the results of a survey undertaken early this year. The survey was an attempt to collect cattlemen's opinions on trich and to better understand the trich disease situation in the state of Nevada. We will also include some estimates of the financial impacts of trich to individual producers, to the Nevada livestock industry and to the state rural community.

Industry Opinion

In late 2002, the Nevada Farm Bureau (FB) approached the Nevada Department of Agriculture (NDA) regarding the possibility of regulations to control trich in Nevada. The issue was brought to the Nevada Cattlemen's Association (NCA) Animal Health Committee for their consideration in the fall of 2002. The committee voted against such action. Each fall since then the subject has been brought up by NCA's Animal Health Committee with similar results until the fall of 2005. Last fall, the committee was split, with half wanting mandatory annual testing and the other half wanting required testing of adjacent positive operations. One of the most consistent issues, since 2002 brought to the attention of NDA has been: Producers testing annually and culling positive bulls are having problems becoming re-infected by adjacent producer's bulls. This causes increased bull replacement costs as well as decreased calf crops even when vaccination is implemented. A survey was planned to better understand producer's concerns and opinions regarding trich in Nevada. This survey was undertaken by NDA with the help of the Nevada Farm Bureau, the Nevada Cattlemen's Association, and the University of Nevada Cooperative Extension (UNCE). Surveys were mailed out by FB and NCA to their respective members, surveys were emailed out through the email list serve "Extension Coffeeshop" and surveys were handed out at the 2006 UNCE "Cattlemen's Update".

A total of 196 surveys were returned by Nevada producers. These producers reported owning 148,000 head of beef cattle. Using the latest Nevada agriculture statistics, this represents approximately 31% of the beef cattle operations by cattle numbers. (National Agriculture Statistics Service (NASS) lists 1300 beef producers with one or more head and a total population of 474,000 total beef cattle for 2005) 14 counties were represented; Storey, Carson City, and Clark Counties had no respondents. The average number of cows per operation was 494 head. The percentage of operations that utilize public grazing was 72%. The percentage of operations performing trich testing in their bulls at some time was 69%. The percentage of operations performing annual trich testing was

43%. The percentage of operations reporting a trich problem in the past was 38%. The percentage of operations using the trich vaccine in their cows and heifers was 38%.

The attitudes regarding trichomonosis regulation are as follows: The percentage of producers that would like to see some form of trich regulation was 83%. The 83% that answered yes to some form of trich regulation were then asked to answer the following. Only those that answered yes are included. The percentage that would want bulls entering NV to be trich tested was 90%. The percentage that would want mandatory testing of beef bulls prior to sale was 78%. The percentage that wants mandatory testing of all bulls from a positive ranch was 94%. The percentage that wants mandatory testing of all bulls on adjacent ranches to positive operations was 80%. The percentage that wants mandatory testing of all bulls prior to turnout on public grazing was 74%. The percentage that wants mandatory annual testing of all beef bulls was 57%. The percentage that wants mandatory slaughter of all trich positive bulls was 88%. This survey was by no means a scientifically based survey of all Nevada producers. However a significant number representing 31% of the cattle numbers did respond. This indicates that the industry would like to see some form of regulation adopted to better control trichomonosis. The Nevada Board of Agriculture after consultation with the FB and NCA, has the proposed regulations for trichomonosis control found at http://agri.state.nv.us/Revised_135-06_V6trichregs.pdf. These regulations may be finalized at the December 2006 meeting of the Board of Agriculture.

The Dollar Cost of Trich

The financial impact of Trichomonosis in Nevada is difficult to get a complete picture of the problem. In 2005, 80 trich positive bulls were found out of 3400 Nevada bulls tested by NDA's Animal Disease and Food Safety Laboratories. This amounts to an incidence of 2.35%. In all likelihood this is an underestimation of the incidence in the statewide bull herd because many infected herds are not testing. Total beef bull inventory is estimated at 15000 by NASS. Using the 2.35% figure, there would be a total of 353 positive bulls in the state if all bulls were tested. The total producer cost for these bulls is estimated to be \$705,882 (average purchase cost of \$3,000 less salvage value of \$1,000). Each infected bull will infect a number of cows and these infected cows will potentially infected one to several clean bulls. If each infected bull reduces the producer's calf crop by 10 to 20 head, the financial loss in calf crop would be \$6,500 to \$13,000 (average calf estimated to be worth \$650) per infected bull. Using those figures the current calf crop loss statewide would be \$2,300,000 to \$4,600,000. Adding the bull cost and the calf loss cost the figures become \$3,000,000 to \$5,300,000. These figures are on the conservative side. In addition it is important to estimate the fiscal impact to the communities as a whole. Research in Eastern Nevada provides multiplier effects from the livestock sector. In others words what happens to the rest of the community if there is a loss in the livestock sector. If a community has a livestock sector multiplier of 2 the loss to Nevada communities could be estimated at \$6,000,000 to \$10,600,000. These are very significant numbers from an industry standpoint, as well as rural Nevada communities.

What is the loss to the average producer? To determine this, the authors have used a program developed by UNCE to estimate producer's costs and incomes. These estimates are based on a 350 cow herd in central Nevada. The three scenarios are: No trich with 85% calf crop and calving interval of 90 days, Acute trich with 50% calf crop and calving interval of 120 days, and Chronic trich with 85% calf crop and calving interval of 180 days. This program takes into account the majority of expenses including interest and depreciation. The table below outlines the annual income and loss associated with the outlined situations.

	Net income/loss
No Trich	\$15,500
Acute Trich	-\$53,700
Chronic Trich	-\$3,000

The difference between no trich and acute trich is more than \$69,000 and would represent a significant financial strain on an operation if not an outright crisis. A chronic trich situation amounts to more than \$18,000 which is significant to the long term profit potential of the ranch and the ranches ability to survive market changes. It is interesting to note that one of the major industry groups urging South Dakota to develop a trich control program was the agriculture lending faction.

The past three articles have covered the cattle venereal disease trichomonosis, what other western states are doing to control trich, producer's opinions on trich and the potential costs to Nevada producers from the disease. If you would like to discuss this topic, do not hesitate to contact David Thain at 775-784-1377 or dthain@cabnr.unr.edu.

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Investigation of use of the PortaSCC® milk test to determine somatic cell count (SCC) and detect subclinical mastitis in sheep. E. R. Kretschmer*1, D. W. Holcombe¹, E. Huether¹, G. Fernandez¹and M. Polak¹, ¹University of Nevada, Reno.

Introduction

Mastitis is defined as an inflammation of the udder caused by infection or undue stress on the mammary tissue. Mastitis can be classified into two categories, clinical or subclinical infection. The producer can often visually diagnose clinical mastitis, whereas subclinical mastitis can only be detected by methods of milk testing. A testing method commonly used to determine subclinical mastitis is analysis of somatic cell count (SCC) which is the number of white blood cells found in milk. Somatic cell count increases when an infection is present, and can be and indicator of subclinical mastitis.

Mastitis can result in many losses for the sheep industry including premature culling, a decrease in milk quality and quantity, poor lamb growth resulting in low weaning weights, and in severe cases, death. Watson and Buswell (1984) reported that 46% of the culled ewes were culled due to mastitis. Producers may prevent premature culling of ewes by developing management practices that will decrease the amount of subclinical mastitis in their flock, which can increase the profitability of the flock. An applicable and affordable management practice that may be utilized by producers to reduce or treat subclinical mastitis in their flock is needed.

The PortaSCC® milk test (PortaScience Inc., Moorestown, NJ) is an easy to use, relatively inexpensive (\$0.90/ udder side or \$1.80/ ewe) on-farm test now used in the dairy industry. The test consists of a simple test strip and activator solution. The strip changes color depending on SCC levels detected in the milk and can be read 45 minutes to 2 hours after the milk sample has been applied, thereby allowing the producer a rapid

on-farm tool for detecting subclinical mastitis. The objective of this study was to determine the efficacy and accuracy of the PortaSCC® milk test in determining SCC and subclinical mastitis in sheep.

Materials and Methods

Animal Management. Ninety-two Ramboiullet-cross multiparous and primiparous lactating ewes (2-6 years of age) were used in this study. Following weaning the ewes were maintained as two separate flocks on pasture through the breeding season and until shearing. After shearing the ewes were moved to a covered barn and placed in pens (16 ft x 32 ft) and pen-fed alfalfa pellets a week prior to parturition, during the lambing weeks and for the first 60days following parturition. Ewes were group fed 4 lbs alfalfa pellets/head/day before parturition. Following parturition, the ewes were pen fed 6 lbs alfalfa and .5 lb of corn/head/day. All ewes in this trial were allowed free access to water and mineralized salt blocks. Ewes lambed within about a 5-wk period. Each ewe's age and lambing status (triplet, twin or single births) was recorded as well as any changes in suckling status during the lactation period. Ewes were milked on day of weaning (approx. 89 ± 16 days) and 24 hours post weaning.

Milk Sampling. Before sampling, udders were disinfected with isopropyl alcohol and the first ~3 mL of milk from each teat was stripped and discarded. A 40 mL sample was collected from each udder half for analysis of SCC. Milk samples were kept cool until delivery to the laboratory. Upon arrival at the laboratory the milk samples were gently shaken and one drop of milk was pipetted from each sample tube onto the sample window of the PortaSCC[®] milk test strips. Three drops of activator solution was added to each strip. The strips were allowed to develop for 1 hour during which time a color

reaction took place depending on the SCC level in the milk. The blue color generated by the color reaction was read using visual comparison to the Quick Check Color Chart produced by PortaSCC[®]. One of four colors (A, B, C or D) was recorded for each test strip; color A is white and colors B, C and D are increasingly darker shades of blue. Colors A, B, C and D represent SCC of < 200, 200, 750 and 2,000 x 10³ cells/ mL respectively.

The 40-mL milk tubes were sent to the Dairy Herd Improvement Association (DHIA) laboratory located in Fresno, CA for SCC analysis determined by a Bentley 2000 component analyzer (Bentley Instruments Inc). The results from the PortaSCC® test strips were compared with actual SCC values determined by the DHIA. The data from the color reading and DHIA SCC results for each ewe were compiled to find the SCC ranges represented by each color (Table 1). No difference was detected (P = 0.29) between colors A and B; the two colors remained within their projected SCC ranges (A = $< 200 \text{ B} = 200 \text{ to} < 750 \text{ x } 10^3 \text{ cells/ mL}$). In a study by McFarland et al., average cell counts for sheep determined not to be infected with subclinical mastitis were 150 x 10³ cells/ mL, whereas the average for cell counts in sheep determined to have subclinical mastitis was 14,000 x 10³ cells/ mL. Somatic cell count ranges reported for colors A and B remain within normal SCC limits of a healthy udder. Values reported for color C were greater (P = 0.005) than SCC values observed for colors A and B, but less (P = 0.0001) than values reported for color D. The actual SCC for color C was $991 \pm 153 \times 10^3$ cells/ mL which would be within the 750 x 10^3 to < 2 million cells/ mL cell range reported for color C. Any SCC count values in this range would be considered to be near the value associated with subclinical mastitis. Color D represented at least 2 million cells/ mL and

all SCC values reported for this range exceeded that threshold with the mean above 7 million cells/ mL. Udder sides with SCC in the C or D color ranges would be considered to have subclinical mastitis and the producer would be recommended to cull the ewe.

Table 1. Somatic cell count (SCC) ranges (cells/ mL) represented by color changes of PortaSCC[®] test strips.

	Color a,b				
	A	В	C	D	
_	(n = 298)	(n = 18)	(n = 22)	(n = 15)	
$SCC \times 10^3$	132 ± 42^{c}	351 ± 169^{c}	991 ± 153^{d}	$7654 \pm 185^{\rm e}$	

^a Color refers to different shades of color observed on the PortaSCC quick check color chart.

Implications

These results suggest that the PortaSCC[®] milk test may be used by sheep producers to determine SCC on the farm and thereby identify ewes that have subclinical mastitis. The PortaSCC[®] milk could be used as an inexpensive, on-farm test for subclinical mastitis, giving the producer the opportunity to cull or treat the affected animal(s) and improve herd health and productivity.

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^b Color A, B, C and D = $< 200, 200, 750, 2,000 \times 10^3 \text{ cells/ mL}.$

c,d,e Row values with different supercscripts differ; SCC x 10^3 (P ≤ 0.005).

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WILDFIRE MANAGEMENT FOR RESOURCE SUSTAINABILITY AND MULTIPLE USE VALUES

Kent McAdoo, Area Natural Resources Specialist, Univ. Nevada Coop. Extension Brad Schultz, Extension Educator, Univ. Nevada Coop. Extension Sherm Swanson, State Extension Range Specialist, Univ. Nevada Coop. Extension Gary Back, Principal Ecologist, SRK Consulting (U.S.), Inc. Barry Perryman, Range Scientist, Univ. Nevada College of Biotechnology, Agriculture, and Natural Resources
Rick Orr, Area Conservationist, Natural Resources Conservation Service Gary McCuin, Rangeland Specialist, Nevada Dept. Agriculture

INTRODUCTION

What can we learn from the conditions leading up to the wildfires that burned nearly one million acres in Elko County this year? Can these fires be avoided? If not, can the large acreages at least be reduced in the future? What is the role of wildfire as a "natural" occurrence"? Perhaps more importantly, how can we appropriately invest in fuel management strategies that should reduce the enormous fire-fighting costs such as we have incurred over the last 7-8 years? Even more specifically, can livestock grazing be used effectively to manage fuel loads and ultimately reduce the size of individual fires that inevitably occur? Ultimately, can we plan and implement landscape-scale management for renewable natural resources production and resource use sustainability?

The authors don't claim to have perfect answers to these questions. However, we hope to stimulate thought by reviewing Great Basin fire history and plant ecology, plant-animal relationships, and the probable results of active vegetation management. Obviously, land managers and users must move forward with decisions and actions, but better management decisions will be made if we understand and integrate existing knowledge.

HISTORICAL PERSPECTIVE

Pre-settlement Vegetation

Before European settlement, much of the Intermountain West was visually dominated by shrubs (Vale 1974), but "spotty and occasional wildfire probably created a patchwork of young and old sagebrush stands across the landscape, interspersed with grassland openings, wet meadows, and other shrub communities" (Paige and Ritter 1999). However, the journal accounts of early explorers indicate that some fires were apparently quite large. Whether or not Native Americans historically played a significant role in using fire as a land management tool in the Great Basin is still being debated, although many historical accounts give that indication (Griffin 2002).

In drier regions of the Great Basin where the "Wyoming" subspecies of big sagebrush dominates, fire ecology was different than that in upper elevations where the "mountain"

subspecies of big sagebrush is more common. According to Miller and Eddleman (2001):

"The Wyoming big sagebrush and low sagebrush cover types, with less frequent disturbance events but slower recovery rates, and the mountain big sagebrush cover type, with more frequent disturbance but faster recovery rates, created a mosaic of multiple vegetation successional stages across the landscape. In addition, fire patterns were patchy, leaving unburned islands, particularly in Wyoming big sagebrush cover types because of limited and discontinuous fuels. Plant composition ranged from dominant stands of sagebrush to grasslands."

The authors went on to say that, before European settlement, much of the lower elevation sagebrush steppe landscape was probably composed of open shrub stands with a substantial component of perennial grasses and forbs (wildflowers). Lightning-generated and/or man-caused fires in the mountainous areas had similar mosaics caused by differences in slope and aspect, with broken topography and variation in fuel loads resulting in unburned patches after a fire. Extreme weather conditions and insect outbreaks also affected historic patterns of vegetation composition on sagebrush landscapes. The historic vegetation differences among sagebrush plant communities across area and through time are important vegetation management considerations for today's land managers and users to ponder.

What Caused the Existing Conditions on the Landscape?

According to Miller and Eddleman (2001), post-settlement changes in disturbance factors have altered the sagebrush mosaic pattern on Great Basin landscapes. Factors listed by the authors include altered fire ecology, introduction of exotic plant species, improper livestock grazing, cultivation, pesticides, water diversion, roads, mining, recreation, urban development, and the increase in atmospheric pollution. Of these, the combined impacts of the first two (altered fire ecology and exotic species) have probably had the most widespread impacts on sagebrush-grass plant communities.

ECOLOGICAL CHANGES ON THE LANDSCAPE

Let's take a look at some of the specific challenges we currently face on Great Basin rangelands. What about "natural" lightning-started fires on our rangelands? Are they good or bad? Well, it all depends!

Not Enough Fire and Discontinuous Fuel Conditions

By starting with the mosaic of grasses and various aged shrub-dominated plant communities described by Paige and Ritter (1999) and Miller and Eddleman (2001), then considering the historic levels of cattle and sheep grazing from the late 1800s through the early 1900s, we can reconstruct the beginning of the altered fire ecology mentioned above. Historic grazing levels reduced the native perennial grasses (season-long grazing by cattle), forbs (spring grazing by sheep), and kept the shrubs in check (fall browsing by sheep). Presumably, the continuity of the fine fuels (grasses and forbs) was reduced and the sagebrush was kept widely spaced. When lightning struck these

discontinuous fuel areas, the result was very little spread of the fire. So for a period of over fifty years, large range fires were not very common. This is indicated in the lack of range fires reported in the local newspapers of the day.

As grazing on public lands came under more control in the 1930s and as the large numbers of sheep declined, sagebrush increased in size and density. This most likely resulted in a competition-caused decrease in grasses and forbs. The historic excessive grazing levels also allowed halogeton and cheatgrass, both undesirable weeds, to increase. Cheatgrass, inadvertently introduced and first observed in Elko County in 1906 (Young and others 1987), slowly spread into the low elevation, low precipitation, grass-depleted ranges. Although not considered an invasive species early on, cheatgrass did dominate some small areas, but more importantly began spreading into the sagebrush stands, filling the interspaces between shrubs voided by the historic grazing on perennial grasses.

By the 1960s, shrub densities reached a point that allowed range fires to spread as crown fires – spreading from shrub to shrub with or without fine fuels in the understory. Thus, the discontinuity of fuels that had limited rangeland fires for many decades changed to continuous fine fuels (cheatgrass under the shrubs) and continuous heavy fuels (dense sagebrush), leading to intense and large fires. These intense fires resulted in high mortality on the remaining perennial grasses and forbs, opening the door for cheatgrass to spread even more and dominate. The Bob's Flat area near Dunphy is a classic example of this phenomenon. Despite repeated attempts to rehabilitate this site, cheatgrass is still a major component of the area.

Too Much Fire and No Perennial Grasses or Shrubs

Millions of acres of sagebrush-dominated Great Basin rangelands have burned in the last 10 years, with 1.06 million acres burning this year in Elko County alone. In response, large portions of the lower elevation areas in northern Nevada have become dominated by cheatgrass, an exotic annual invasive weed species. Because cheatgrass germinates before most native species, this weed is highly competitive with desirable native perennial species for both moisture and soil nutrients. Cheatgrass is also more flammable than native grass species, and fires are now much more frequent (every 2 to 15 years) than during the pre-settlement period (every 20 to 100 years) in the same areas.

Because of the fuel continuity of these solid cheatgrass stands (called monocultures), cheatgrass fires are generally larger and more uniform than historical fires in these formerly sagebrush-perennial grass communities. As native plant diversity has declined in the face of this self-perpetuating cycle, large areas in the Great Basin are in danger of further degradation from invasion by perennial noxious weeds that occur in the region. This situation presents an enormous challenge throughout much of the Intermountain West where this downward spiral is occurring. For management to succeed and maintain productive rangelands, society must:

(1) reduce the loss of sagebrush and its perennial understory as a dynamic, but self-sustaining plant community, and

(2) revegetate those large expanses of cheatgrass with resilient shrub-grass-forb communities that will provide habitat for diverse wildlife communities, forage for livestock, and functioning plant communities for other land uses.

Not Enough Fire and Too Many Pinyon and Juniper Trees

In some portions of the Great Basin, native pinyon and juniper trees have gradually encroached into adjacent sagebrush communities. Part of this change may be driven by warmer and moister winters and earlier run-off periods, allowing for better tree seedling survival. However, this invasion has been exacerbated by a change in fire frequency. In this case, decades of fire control and the grazing of fine fuels have decreased the frequency of natural fires that historically kept pinyon and juniper restricted to higher elevations. Fire every 40 to 50 years would have periodically removed the pinyon and juniper from sagebrush stands and restricted them to comparatively "fire-safe" sites. Litter (dead plant material) accumulation, changes in soil chemistry, and/or juniper's intensive year-round competition for soil moisture suppress the establishment and survival of shrub and herbaceous species (ladder fuels) under tree canopies. This in turn reduces the plant diversity that supports sagebrush-associated wildlife species and provides forage for livestock. The management challenge is restoring periodic fire or some fire "surrogate" (like tree thinning or chaining) to re-create the dynamic tension among herbaceous plants, sagebrush, and scattered small trees. Appropriate balance in the composition of the vegetation allows the vegetation to return to a perennial grassforb state after disturbance, then eventually shrubs, thus maintaining a resilient cycle.

<u>Too Much Sagebrush, Sparse Perennial Grass, and Areas at Risk to Cheatgrass</u> Conversion

Another habitat condition is perhaps being overshadowed by the cheatgrass and pinyon-juniper problems. Much of the Great Basin has large expanses of sagebrush habitat where sagebrush canopy cover is very dense and the desired perennial grasses and forbs are almost absent (McAdoo and others 2004). Some areas have large amounts of cheatgrass beneath the sagebrush. Areas with abundant sagebrush and no perennial grasses are one lightning strike (or human-caused ignition) away from changing to only cheatgrass and losing most of their resource productivity. Keeping these sites diverse and productive for all land uses requires reducing the amount of mature sagebrush, increasing the amount of desired perennial grasses and forbs, and facilitating the regeneration of young sagebrush. Planned wisely, such management would create a patchwork of sagebrush plant communities with different ages of sagebrush and amounts of perennial grasses and forbs. Both wildlife and livestock would benefit, the plant communities would be less likely to become cheatgrass after fires (which are inevitable), and fires may be smaller and have fewer long-term adverse effects.

LIVESTOCK GRAZING FOR FIRE CONTROL

Can livestock grazing reduce the threat of large recurring wildfires? In a word, yes, but with limitations. It all depends on the specific situation, which is a function of scale. Site-specifically, they can be used as a tool to promote rangeland health and productivity and to reduce fire danger (by reduction of fuel-loading). They can also be used to manage

invasive weeds in some cases and even to improve wildlife habitat. Resource management specialists have not done an adequate job of promoting and implementing the use of livestock as a tool to manipulate vegetation to achieve desired plant communities. However, livestock grazing is not the panacea for our environmental woes, especially related to fire ecology. We have current fire-related variables on the landscape that may be largely independent of livestock grazing. One example is the current infestation of aroga moths, sagebrush defoliating insects that over the last three years have killed thousands of acres of sagebrush in northern Nevada. The resulting dead and dying sagebrush may have contributed to the spread of wildfire. But back to the consideration of scale - the use of livestock as a tool to manipulate vegetation for achieving landscape-wide management goals and objectives is a difficult challenge to say the least.

How many cows would it take to remove combustible herbaceous vegetation on a landscape scale? Let's look at an example of a recent (2005) wildfire complex, the multiple fires in the Tule Desert (Lincoln County, Nevada) that impacted 597,000 acres. These fires burned in an area that, due to extremely high precipitation, produced between 1,000 to 2,000 pounds of forage per acre that year in the form of invasive annual grasses. These were primarily two highly flammable species, red brome (another exotic species closely related to cheatgrass) and cheatgrass. Consider that the average amount of forage required for one cow and her calf for one month (a standard unit of measure called animal-unit-month or "AUM") is 800 pounds. Then, to be conservative, let's round this number to 1,000 pounds per AUM, assume that only 400,000 acres were usable rangeland for livestock, and estimate forage production on the low end for that year at 1,000 pounds per acre. Using these values, it would take 100,000 animal units four months to consume all of the annual grass production on all 400,000 acres. This is a simplistic example that accounts for no potential damage to perennial grasses and uses reduced average production figures - it only grossly estimates and does not account for variables like livestock herding techniques and forage discontinuities.

With about 70 million acres and only 500 thousand cows currently in the state of Nevada, it seems impossible to "ramp up" livestock numbers sufficient to achieve landscape-scale fuel reduction for fire protection state-wide. Even if this were possible in some years, what about sustainable production for both the forage resource and the commodity? Where would the excess livestock numbers go during drought years and even during years with only moderate forage production? There is also the question about the impacts of heavy repeated season-long grazing year after year, which arguably can deplete desirable perennial grass understory and leave a niche for more cheatgrass invasion and dominance, as discussed above. Landscape-scale fuel reduction by livestock seems unachievable.

But, on the positive side, strategically located and timed livestock grazing can indeed reduce standing fuel on rangelands, thus decreasing the spread and size of wildfires. We know that cows eat primarily grass, goats can thrive on shrubs, and sheep prefer broad-leafed forbs and weeds during the growing season and shrubs during fall/winter. All of these livestock classes can be used appropriately as tools site-

specifically for reducing fuel-loads. Here are some basics to consider regarding the use of livestock for reducing herbaceous fuel:

- Site-specifically, livestock can be used to reduce cheatgrass cover. Cheatgrass is highly palatable and high in nutritional value in the spring, before the seed cures. Opportunistic intensive grazing at select locations during early growth can reduce the seed crop for that year. The use of cheatgrass must be balanced with the growth needs of desired perennial grasses that managers and producers want to increase.
- Fall grazing of cheatgrass-dominated areas, complemented with protein supplement, should also be considered. After the unpalatable seeds have all dropped, cheatgrass is a suitable source of energy, but low in protein. Strategic intensive grazing of key areas could reduce carry-over residual biomass that would otherwise build up and serve as fuel during the next fire season. Fall grazing when grasses are dormant and seeds have already dropped results in minimal impact to desired perennial grass species and therefore can be conducted with minimal adverse impact to rangeland health in many areas.
- The Bureau of Land Management (BLM) already has an active "green-strip" program in some locations, designed to reduce fire size and spread in key areas. Obviously, livestock can be used in conjunction with such green-strips to reduce the fine fuels (grasses) to control the spread of fire.
- The concept of "brown-strips" (NNSG 2004) refers to areas where shrub cover is reduced and the native perennial grasses are released, creating preferred areas for livestock to graze and reduce fuels, leaving a "brown-strip" when the stubble dries out in mid-summer. These areas can serve as fuel breaks to control the spread of wildfire. Brown-strips can be created by using prescribed fire, mechanical thinning, or herbicide to reduce shrub density. Where needed, supplemented cull cows or sheep could be used to intensively graze and create brown-strips (for example, along fences) to reduce the spread of fires during or after years of excess herbaceous fuel build-up.
- Prescribed grazing for the management of herbaceous fuels requires a very high level of control for livestock movement, the timing of grazing, and grazing intensity. Such intensive "prescription grazing" can reduce livestock body condition, particularly when low quality feed is the primary forage. Animals must be pressured by herding, electric fencing, or other methods to clean areas completely when they have a natural desire to move on to "greener pastures." Because of this need to "force-feed" livestock in the intensive grazing situations described above, land management agencies should have the option of contracting such jobs to willing producers, paying them for the ecosystem service rendered. This payment approach is already being implemented in some private and agency-managed areas to a limited extent, primarily for noxious weed control. The authors maintain that use of and payment for prescription livestock grazing as a tool has substantial potential in the immediate and foreseeable future for managing vegetation in site-specific situations on Nevada's rangelands.
- In general, and less intensively, livestock grazing can be used strategically for timing- and duration-controlled grazing to great advantage in prioritized pastures where reduction of even perennial grass cover is required. Strategic locations each year could be grazed annually to reduce fuel loads and continuity at

specific locations. Rotation of locations across years prevents overgrazing of any one area but confers the benefits of fuel load reductions to much larger landscapes. Even moderate grazing and trampling can reduce fuels and slow fire spread.

The strategies discussed above all require a very flexible adaptive
management approach by both land management agencies and producers.
Management objectives must be determined, followed by selection and
implementation of the appropriate livestock grazing prescription (tool),
monitoring of accomplishments, and adjustments as needed.

2006 FIRE SEASON OBSERVATIONS

The following characteristics of the 2006 fire season make it unique in some ways, and are worth considering:

- Precipitation amounts and timing in northeastern Nevada during 2005-2006 resulted in two consecutive growing seasons with much higher than average production from grasses, including one year of phenomenal production (2005).
- Northeastern Nevada also experienced the build-up of dead and dying sagebrush resulting from an aroga moth (sagebrush defoliator) infestation that has killed large tracts of sagebrush during the last three years. The sagebrush die-off has likely resulted in an increase in native perennial grasses where these species were present and an increase in cheatgrass where the understory was depleted, increasing the fine fuels in both cases.
- Along with the conditions described above, there was a succession of drylightning storms accompanied by low humidity, high temperatures, and often very high winds. These storms ignited fires repeatedly in northeastern Nevada for more than two months.
- The majority of the lands affected by fire during 2006, unlike many previous years, was in higher elevation big sagebrush communities with a good understory of native perennial grass species (versus low-lying areas with cheatgrass dominance and/or invasion potential).

<u>To seed or Not to Seed – a Matter of Elevation, Topography, and Prior Vegetation Condition</u>

The potential for natural recovery of vegetation in the higher elevations after fire is excellent. Post-fire response of native perennial grasses and forbs, given at least average precipitation, can be phenomenal within two years after fire if these species were abundant before the fire, with shrubs gradually re-establishing over time. The authors base their opinion on observations of the resiliency of fire-ravaged areas that burned at higher elevations in 1999 and 2000. We have seen this resiliency response manifested at the Boies and Cottonwood ranches in northern Elko County, locations in central Nevada, and elsewhere.

This pattern strongly suggests that the seeding of crested wheatgrass and other nonnative species in such high elevation areas (typically where precipitation is at least 10 inches annually) is unnecessary in most cases and therefore would be unwise both economically and ecologically. Furthermore, aerial seeding is the only option in such steep and rugged terrain, and most aerial seeding is unsuccessful because the soil-to-seed contact required for seed germination is not typically achieved.

However, in lower elevations of the 2006 fires where, due to prior conditions cheatgrass is anticipated to substantially increase, land management agencies and private landowners alike would be well-advised to seed non-native plant species like varieties of crested wheatgrass. These species are site-adapted to these arid lands (approximately 8 inches of annual precipitation), very competitive with cheatgrass and other weeds, less expensive than native species, and are much more reliably established with available equipment under average precipitation levels. For these reasons, the seeding of crested wheatgrass in these cheatgrass-prone areas after fire has been standard practice by the BLM since at least the 1999 fire season.

The track record in establishing native perennial grasses in these arid low-elevation sites is very poor. When our initial seeding attempts fail, cheatgrass typically becomes established. Cheatgrass-dominated sites are very difficult to re-seed until the cheatgrass can be effectively controlled, a very difficult and often prohibitively expensive task. But if we start by seeding crested wheatgrass, then once this species successfully out-competes cheatgrass, we can interseed native species if desired. This multi-phased approach, called "assisted plant succession" by vegetation specialists, can restore some plant species diversity to improve wildlife habitat in these areas. Many old crested wheatgrass seedings where sagebrush has re-established naturally over time now support sagebrush-dependent wildlife species, along with providing livestock forage (McAdoo and others 1989). It is certainly much better to have a functional perennial plant community dominated by non-native crested wheatgrass than one dominated by annual cheatgrass and/or other invasive weeds.

ACTIVE VEGETATION MANAGEMENT – KEY TO HEALTHY RANGELANDS

Any sagebrush community with a depleted native understory (and reduced biodiversity). especially if adjacent to a cheatgrass or noxious weed infestation, is just a lightning strike or human-caused ignition away from being irreversibly lost in terms of ecological health and resource productivity. In the sagebrush ecosystem, active management is essential for maintaining current levels of production on healthy rangelands and improving resource potential on sites that have lost their perennial grasses and forbs. Active management by definition means the manipulation of one or more resource attributes. It may involve the use of prescribed fire or fire surrogates, seeding desirable species, herbicide application, and/or management-intensive grazing to ensure we have landscapes that are resilient after disturbances that eventually will occur. Only through active vegetation management will society have ecologically sustainable rangelands that meet our broad needs. Success in establishing a diverse mosaic of perennial plant communities across a sagebrush landscape (as described by Miller and Eddleman 2001) will reduce wildfire and ensure that appropriate vegetation is present for both wildlife habitat diversity and livestock forage, along with the potential for other sustainable rangeland multiple uses as well.

Current ecological thinking suggests that every ecological site (e.g., sagebrush community) can produce multiple desired and undesired plant communities or vegetative states, with each plant community having the potential to transition among several phases. Simply stated, this "state and transition models" concept (Laycock 1991), indicates that some plant communities (e.g., sagebrush with a cheatgrass understory) have already crossed ecological thresholds (points of "no return") that make them virtually unrecoverable in terms of both biological diversity and resource production. They cannot progress back to a sagebrush-bunchgrass community following normal management actions. However, areas that are nearing such a threshold can, with appropriate active management, be recovered. Such vegetation management can promote rangeland health and productivity and reduce wildfire acreage losses. We need to recognize and treat plant communities that are approaching these nearly irreversible thresholds and manage them accordingly before time runs out.

For areas that are teetering near a threshold, we must take active management control. For example, direct vegetation manipulation, e.g., using prescribed fire or a fire surrogate for shrub reduction to reduce competition and seeding with desirable herbaceous species may be required. Little or no timely response would be anticipated from the passive management of just removing the livestock. To assume otherwise is being naïve/unrealistic. However, after desired vegetation is established, proper livestock management is absolutely necessary to prevent the undesired situation from re-occurring.

Without active management (typically including seeding), the next fire will push these communities across thresholds, resulting in large rangeland areas that are prohibitively expensive to successfully revegetate. For example, after a low elevation sagebrush-grass community has crossed the ecological threshold to dominance by cheatgrass, the transition is irreversible without a very large investment of time, effort, and money to effect a positive change. Worse yet, these altered plant communities such as cheatgrass monocultures are even more fire-prone and fire-perpetuated, and are more susceptible to invasion by even less desirable species like noxious perennial weeds. Repeated fires in these areas will undoubtedly further reduce the ecological and economic potential for most land uses.

In areas that are declining but not as close to thresholds, with an understory of desired species but needing more herbaceous cover, livestock grazing management and prescribed fire could be used as tools for producing positive change. With appropriate grazing management, areas alternately rested or allowed to re-grow after early grazing, then occasionally burned, could become part of a mosaic landscape simulating presettlement plant communities varying from dominant stands of shrubs to near-grasslands (Miller and Eddleman 2001).

HOW DOES ALL THIS RELATE TO "NATURAL" CONDITIONS?

Within the last decade, land management agencies began advocating ecosystem management, but in large part, the approach has been more passive than active. We

know that "active management" may be offensive to some, especially with regard to large seemingly "pristine" western landscapes, but the more knowledge we acquire about bioregional history, the more it is evident that <u>humans</u> have always been involved in landscape and ecosystem management, for better or worse, since their arrival on this continent. To "not manage" is really passive management, and has definite repercussions (Perryman and others 2003).

An increasing number of scientists and bioregional historians have recently indicated that active vegetation management of landscapes, particularly where fire is concerned, is historically supported and necessary (Pyne 2004; Mann 2005). According to Charles Mann (2005, p.326) in his new book "1491 – New Revelations of the Americas before Columbus," there is strong evidence that "Native Americans ran the continent as they saw fit. Modern nations must do the same...if there is a lesson, it is that to think like the original inhabitants of these lands we should not set our sights on rebuilding an environment from the past but concentrate on shaping a world for the future."

CONCLUSIONS

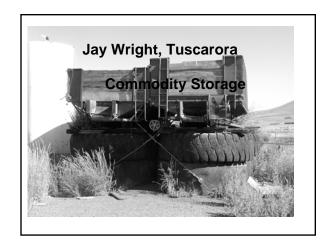
Since European settlement, many changes have been wrought on the Great Basin landscape. By looking at land use in the context of history, we have a reference point from which to help us make management decisions. We know that society wants clean air and water, recreation, red-meat production, open space, etc. We also understand, at least in part, the habitat requirements of many wildlife species, from rodents and songbirds to big game species. Although our understanding of ecological relationships is not perfect - and never will be – society must apply the knowledge we have as appropriately as possible. We can't afford not to. Today's buzz-word, "adaptive management," certainly applies here. In a world of accelerated change, society must actively manage ecosystems at the landscape scale. These landscapes will change with or without our efforts, but only our thoughtful implementation of appropriate management actions can increase the probability that change will meet society's needs. We must apply the best knowledge available, monitor the results, and make the necessary adjustments to improve long-term results. This approach must include all aspects of fire management that provide for the healthy and productive rangelands we require.

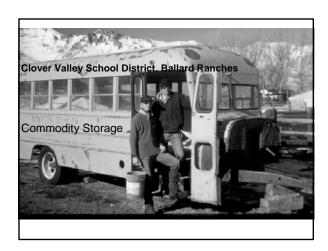
Active vegetation management on a landscape-scale is expensive and must be accomplished in stages. Highest priorities should be driven by the risk of crossing an irreversible vegetation threshold and maintaining opportunity to apply effective management. The sustainable production of wildlife habitat, livestock forage, and other rangeland resources is something over which resource managers can have some control. Oh sure, there are the vagaries of nature that are beyond our control. But as human beings, we certainly have the knowledge to impact our environment for better or worse. The challenge is whether society chooses to use its knowledge wisely or not. Active vegetation management, taking direct control of landscapes, is mandatory when plant community functionality, landscape diversity, and wildfire impact reduction are at stake.

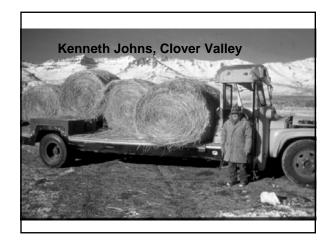
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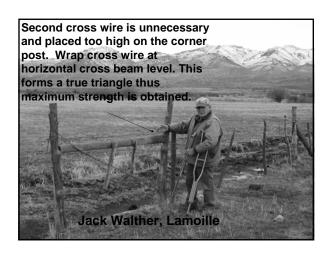


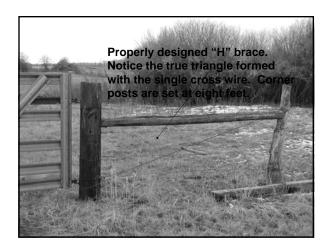


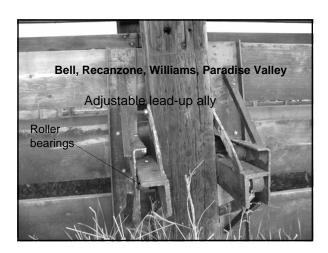




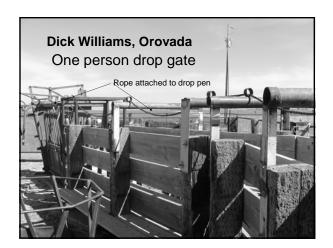


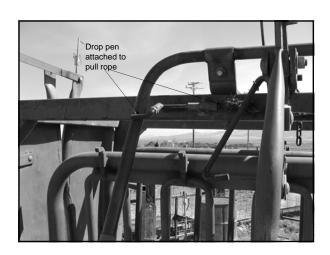








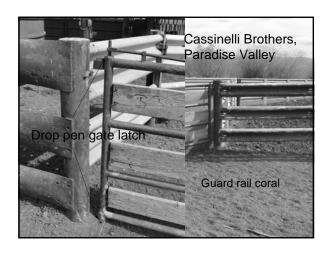


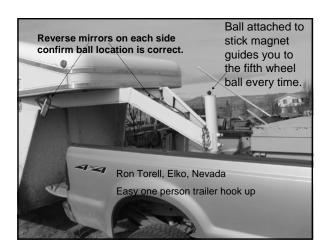




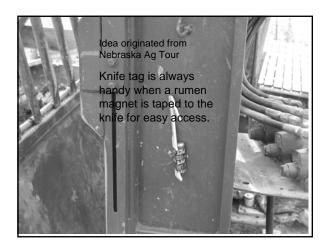






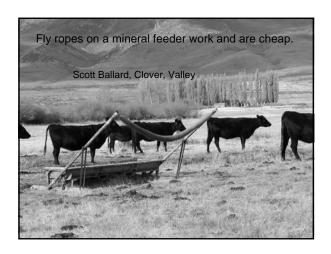


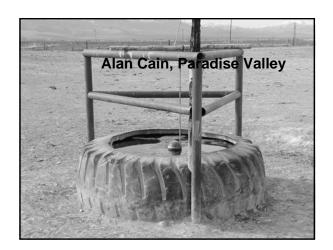


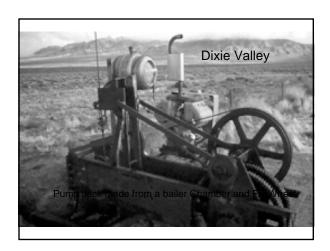


















College of Agriculture, Biotechnology and Natural Resources

Also known as CABNR, this college houses 5 distinct departments: Animal Biotechnology; Biochemistry and Molecular Biology; Natural Resources and Environmental Science; Nutrition; Resource Economics

This is a diverse college and we offer many opportunities to students. Besides our many majors, students may work in a lab that is studying important issues such as stem cell research, assist with "lambing" on the University farm or even travel to Washington, D.C. to work as an intern.

The five departments offer 11 different majors, which prepare students for jobs in many areas. We have graduates in private industry, medical school, law school, veterinary school and the public sector.

Animal Biotechnology

Many students choose our <u>Veterinary Science</u> major. This is a pre-professional program for students preparing for veterinary school. The Veterinary Science major is very popular and we are proud to say that our students have a 60% acceptance rate to professional veterinary school.

<u>Animal Science</u> is a major designed to provide students training in various aspects of the livestock, food and fiber industries. This major prepares students for careers in animal production management, feed manufacturing, livestock marketing or extension work. Many of our Animal Science students go on to graduate or veterinary school.

The Animal Science Department has an <u>Equine Science</u> option for students who want to specialize in that growing industry. This program offers a broad understanding of the horse industry and its relationship to business and recreation. <u>Rangeland Livestock Production</u> option studies the interaction between plants, livestock and wildlife as well as how grazing systems influence management of these resources.

Our <u>Animal Biotechnology</u> major prepares students for the expanding biotechnology industry. This major gives student a strong scientific background encompassing both theoretical and practical training with molecular and biochemical techniques.

Resource Economics

In <u>Agricultural and Applied Economics</u>, students study the broad area of economics with an emphasis in natural resources, agricultural production and environmental management. These students will be our future leaders in agribusiness, finance and economic development. Environmental Policy Analysis is a closely related major that is an excellent pre-law degree.

Natural Resources and Environmental Sciences

Our <u>Environmental Science</u> major provides students with strong science background coupled with courses in environmental issues. This degree is critical for addressing today's environmental issues: global climate change, pollution and the use of natural resources. Students may also choose an optional focus on <u>Watershed Science</u>.

Our <u>Forest and Rangeland Management</u> major provides a solid foundation for science-based decision-making in natural resource management. This is the career path for those interested in managing public lands and protecting our valuable forest and rangeland resources.

<u>Wildlife Ecology and Conservation</u> is a field that emphasizes wildlife biology and conservation based on ecological principles. This major prepares students for addressing wildlife management issues.

Nutrition

The newest addition to our College is the Department of Nutrition. The Nutrition major offers two degree options: <u>Nutritional Sciences</u> and <u>Dietetics</u>. Students from these majors are well prepared for other health-related professional schools, such as medical, dental and pharmacy.

Biochemistry and Molecular Biology

Our <u>Biochemistry</u> major provides an excellent background for biotechnology research, medicine, dentistry, pharmacy, nutrition, veterinary medicine and education. This challenging program has been the starting point for many of our graduates as they head to medical school.

Student Ambassadors

To assist CABNR, we have an elite student group known as "Student Ambassadors." Their mission is to recruit students, assist new students in the transition to college life and serve as liaisons between the college, its supporters and surrounding communities. They are involved at many levels on campus. Many are student employees or are involved in our various clubs and organizations. They manage to keep up with their studies (maintaining a 2.75 GPA is required), meet on a weekly basis and attend various recruiting functions around the state. The Ambassadors are as diverse as our college. They are well versed in providing information to potential students and are at ease presenting to groups. They have been welcomed by many high schools across the state and relate well to students and their parents.

Student Center

The CABNR Student Center provides support services for CABNR students. The Student Center assists the students with advising contacts, and the processing of paperwork (change of major forms, graduation applications, scholarships, etc) throughout their college career. The Student Center is a place where students pop in for advice, moral support or just a friendly hello. There is a Student Lounge with plenty of room for group study and computers for the use of CABNR students.

For more information about our programs, our Student Ambassadors or the Student Center, please feel free to contact the Student Center at 775/784-1634. You can also visit our website at http://www.aq.unr.edu/cabnr/