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Eastern Oregon Agricultural Research Center Annual Report, 1995

Agricultural Experiment Station
Oregon State University

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Front Cover: Paiute Butte on the Northern Great Basin Experimental Range. Harney County, Oregon
Photo by Ray Angell

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*Agricultural Experiment Station
Oregon State University
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FOREWORD

This Special Report is provided to you as a brief update on the activities and research direction of the Eastern Oregon Agricultural Research Center. The Center has offices in both Union and Burns, Oregon, and includes USDA's Northern Great Basin Experimental Range, located about 35 miles west of Burns as well as OSU's Hall Ranch which is about 12 miles southeast of Union. These facilities provide us with a unique combination of improved pasture, native meadow, riparian, forested range, and sagebrush steppe communities in which to conduct research. In addition to on-station research, scientists and staff at EOARC conduct cooperative research on public and private land throughout eastern Oregon, as well as with scientists throughout the western United States.

You will find information on a wide variety of topics in this year's report. Ecologically oriented papers discuss new ecological theories concerning vegetation change, results from plant community research, and climatic effects on vegetation. Several papers present recent and planned work relating to wildlife-livestock interactions. Livestock management topics addressed include nutrition, mineral status of eastern Oregon cattle, grazing on native meadows, immune status of calves, and livestock behavior. These reports are designed to be brief and to the point. We sincerely hope that you will contact the authors for further information regarding any topic on which you need more information.

Finally, research is a dynamic endeavor. All of us at EOARC encourage you to discuss research needs and ideas with us. We strive to keep the mission and research of this Center at the forefront for both natural resource and agricultural interests. As we move into the last five years of the 20th century we know that demand for food and fiber will continue to increase. Our mission is to meet those needs by developing agricultural and natural resource strategies which sustain and/or enhance ecosystem integrity. With your help, we can meet those needs.

Ray Angell
Rangeland Scientist
USDA, Agricultural Research Service

Alternative Approaches to Rangeland Management

Tony Svejcar and Roger L. Sheley

SUMMARY

Traditional range management is based on the ecological concept of the climax plant community, that is, the community which will dominate a site if disturbance is removed. Disturbance is viewed primarily as drought and/or livestock grazing. Under this approach, it is assumed that if overgrazing or drought caused a shift from the climax plant community, then simply removing grazing or returning to a normal precipitation pattern would allow the plant community to return to climax. This traditional ecological concept has been applied to agricultural fields with the intention of returning them to native vegetation. Theoretically, "go-back" fields and weed-infested sites should return to the climax plant community given enough time. However, there are many examples where this concept fails. For example, once western juniper gains dominance in a sagebrush community, only fire or mechanical removal will cause the community to return to the sagebrush/bunchgrass "climax". There are many examples of exotic weed invasions (e.g., cheatgrass, yellow starthistle) that have resulted in apparently permanent infestations. Ecologists generally agree that the ecological basis for traditional range management does not adequately explain the observed patterns of vegetative change. Ecological theories consistent with observations have been developed. We suggest that a new approach to range management, based on current ecological thinking, is required. One alternative is the "state-and-transition" approach, where potential plant communities (states) and observed factors allowing changes from one community to another (transitions), are catalogued for general types of rangelands. Managers refer to these historical catalogues to guide their decisions. If we include the primary ecological causes of vegetation change, that is, availability of suitable sites, availability of species, and the relative ability of individual species to survive and reproduce then it may be possible to combine scientifically based research information and management knowledge to predict the plant communities that will result from specific management actions.

INTRODUCTION

The ecological basis for traditional range management has been the climax plant community concept. This concept arose from ecological theories proposed by Frederick Clements during the early part of this century.

Clements spent 1913 and 1914 studying the vegetation of the western half of the United States. He came to the conclusion that vegetation was very orderly and viewed vegetation formations as complex organisms with characteristic development patterns (Clements 1916). Dyksterhuis (1949) refined the concept and placed it in a context that could be easily understood and applied. Basically stated, a given piece of rangeland will support a climax plant community if there are no major disturbances, and if a disturbance shifts the plant community it will gradually succeed back to climax. In this context, climax is viewed as a stable endpoint. For example, a heavily grazed sagebrush steppe community might be dominated by sagebrush and Sandberg's bluegrass. With reduced stocking rates the community might regain the perennial bunchgrasses, such as bluebunch wheatgrass, Idaho fescue, and Thurber's needlegrass that existed prior to overgrazing. The change from one plant community to another is called succession. This system defined the condition of rangeland by the departure from the climax plant community. A climax community is considered to be in excellent condition, good condition range is a minor shift away from climax, and poor condition would have a community of plant species very different from the climax. This approach provided a means of assessing range condition and resulted in major improvements in the rangelands of the world. The focus on vegetation and ecological principles allowed managers to assess the impacts of management. However, there were only limited attempts to explain why changes in plant communities occurred. There were examples of grazing systems where dramatic improvement in vegetation was observed, and many opinions as to why, yet few scientific studies of the ecological causes of plant community changes have been conducted. With the extensive use of this traditional approach came many examples where it was ineffective as a management tool.

Since the pioneering work of Clements, the field of plant ecology has made great strides. There has been recognition of the fact that disturbance (e.g., fire, drought, flooding, and grazing) is an important component of many ecosystems (White and Pickett 1985), that many plant communities are not at equilibrium with the environment, that climax may not be as constant as once assumed, and that some ecological changes occur more easily than others (there are thresholds). For example, climate has varied over time and some plant communities evolved under a previous climate. These communities may be able to persist because adults have a long life span (e.g., oaks), but they do not reproduce under the current climatic conditions. Thus, management aimed at restoring these relict communities will fail. Several alternatives to the traditional climax approach have been proposed (e.g., Westoby et al. 1989, Friedel 1991). State-and-transition models provide a way of organizing what is known about a particular type of rangeland. Laycock (1992) described such a model for the sagebrush steppe (Figure 1). The various types of plant communities are the potential states (boxes), and the transitions necessary to move from one community to another are defined by the arrows. Transitions are factors necessary to move a plant community in a particular direction, and are based on observation.

Another concept of importance in rangeland management is that of thresholds (Archer 1989, Friedel 1991). A threshold is a change that is difficult to reverse. In eastern Oregon the change from sagebrush/bunchgrass to juniper dominance might be considered a threshold, because returning to sagebrush/bunchgrass can be very difficult, depending on circumstances.

We have previously suggested that state-and-transition models provide a means of organizing information, but are limited in predictive capability (Svejcar and Sheley 1995). We feel that future approaches to range management should include the scientific mechanisms or explanations for why changes occur. Many management decisions are challenged and managers must be able to explain why they expect to see a particular response to a management decision. It appears there is a challenge to use "the best science" when making a management decision. What is lacking is a framework for combining science and management. We favor using the mechanisms of succession proposed by Pickett et al. (1987), i.e., availability of establishment sites, availability of species, and growth of individual species (or the ability to survive and reproduce) to help explain why changes might or might not be expected. For example, we are planning a prescribed fire in the sagebrush steppe and we wish to predict the outcome. We would need to ask the following questions: 1) Will burning open up establishment sites in the community? 2) If so, what species are available to occupy those sites? 3) Of the species available, which will perform or grow the best? If our goal is to increase native perennial bunchgrasses, we must make sure that opening up establishment sites does not result in a sea of the cheatgrass that out-competes the native bunchgrass seedlings. Also, if the appropriate native species are not present, we might want to provide the seed source (i.e., seed the site).

Combining what is currently known about a type of rangeland (summarized in a state-and-transition model) with the ecologically based mechanisms of succession (availability of sites, availability of species, and growth of species) might allow us to blend science and management in a manner that we can predict the outcome of management practices (Figure 2). There is a need for scientists to gain a better understanding of management, and for managers to gain a better understanding of science. We propose Figure 2 as a starting point in what we hope will be vigorous discussion of how to integrate science and management in the future. One advantage of Figure 2 is that economic and time estimates can be placed on each step. The potential communities can also be grouped according to management needs and/or sustainability. For example, potential plant communities 1 to 4 could be rated according to grazing potential during the four seasons. If a ranch lacked fall grazing opportunities, it might be worth considering the option of establishing a community that helps fill that void. The primary questions might be: 1) What type of communities are appropriate? 2) How long will they take to establish? 3) What are the costs and potential returns in the long run?

There are several limitations and concerns that we should mention in closing. First, we agree with Cairns (1990) that random events can influence succession, and therefore we must not assume that any ecological model will have rigorous predictive capability. There must be some flexibility in the predicted outcome. And second, the model must be viewed in a site-specific manner, with managers given the opportunity to develop predicted outcomes for their specific situations. There are no "cookbook" answers that can be applied across landscapes.

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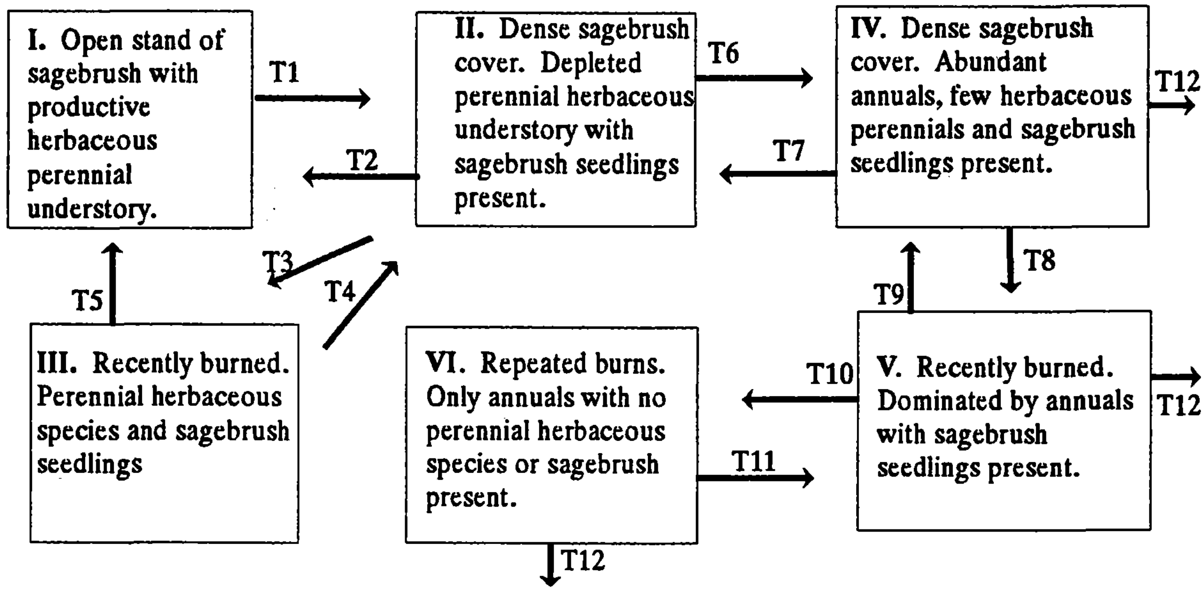
Figure 1. State-and-transition model for a sagebrush grass ecosystem (from Laycock 1992). Notice that some transitions are difficult to cross and can be viewed as thresholds.



State-and-transition diagram for sagebrush-grass vegetation.

Catalogue of Transitions

Transition 1 - Heavy continued grazing. Rainfall conducive for sagebrush seedlings.
Transition 2 - Difficult threshold to cross. Transitions usually will go through T3 and T5.
Transition 3 - Fire kills sagebrush. Biological agents such as insects, disease, or continued heavy browsing of the sagebrush by ungulates could have the same effect over a longer period of time. Perennial herbaceous species regain vigor.
Transition 4 - Uncontrolled heavy grazing favors sagebrush and reduces perennial herbaceous vigor.
Transition 5 - Light grazing allows herbaceous perennials to compete with sagebrush and to increase.

If climate is favorable for annuals such as cheatgrass, the following transitions may occur:

Transition 6 - Continued heavy grazing favors annual grasses which replace perennials.
Transition 7 - Difficult threshold to cross. Highly unlikely if annuals are adapted to area.
Transition 8 - Burning removes adult sagebrush plants. Sagebrush in seed bank.
Transition 9 - In absence of repeated fires, sagebrush seedlings mature and again dominate community.
Transition 10 - Repeated burns kill sagebrush seedlings and remove seed source.
Transition 11 - Difficult threshold to cross if large areas affected. Requires sagebrush seed source.
Transition 12 - Intervention by man in form of seedlings of adapted perennials.

Figure 2. A schematic outline for using successional mechanisms to predict plant community changes. In the example from the text, we might define the current community as sagebrush dominated, choose burning to improve site availability, decide that existing vegetation can provide a seed source, and consider the life histories of the existing species adequate to compete with non-desirable species that might invade. The potential outcome would be a native bunchgrass grassland. Removal of species might also appear in the site availability category (e.g., weed control, followed by seeding, with species performance being dependent on moisture from precipitation).

EXISTING PLANT COMMUNITY

SUCCESSIONAL MECHANISM			
Site Availability	Burning	Protection	Grazing
Species Availability	Additions (seeding)	Existing	Removals (e.g., spraying, mechanical treatment)
Species Performance	Moisture	Nutrients	Life History

POTENTIAL PLANT COMMUNITIES

#1 #2 #3 #4

Changes in an Ungrazed Wyoming Big Sagebrush Plant Community Over Three Years of Different Rainfall

Jeff Rose and Rick Miller

INTRODUCTION

Year-to-year changes in climate can have a significant impact on a plant community species composition. The Great Basin is an area associated with hot,dry conditions and highly variable annual precipitation. Water may be the most limiting resource in the Great Basin for most of the year. The degree that water may limit plant growth will vary from year to year as well as from month to month. Figure 1 shows the variability in the annual rainfall for the Northern Great Basin Experimental Range (NGBER). Average annual (September through August) precipitation is 11.2 inches (283.3) millemeters at the experimental range. However, less than half the years between 1952 and 1994 were close to the long-term precipitation average (80 percent to 120 percent of long-term average). Variability in precipitation at the NGBER is the rule rather than the exception.

Previous work at the NGBER has found that herbaceous plant growth is closely related to precipitation. Recently, we have experienced three very different years at the experimental range. Between 1992 and 1994, the experimental range received 9.6 inches, 20.6 inches, and 5.6 inches. Precipitation in 1993 was almost twice the long-term average, and in 1994 was almost one-half of the same value. Yearly precipitation in 1992 was closest to the long-term average, but still was 20 percent lower than average. Two years preceding 1992 were also below average years, with 1990 being the fourth-driest year on record (1952-1994).

During the period from 1992 to 1994, we evaluated the effects that changes in annual precipitation have on the plant biomass and species composition in Wyoming big sagebrush and Thurber's needlegrass plant communities in southeastern Oregon. We hypothesized that variation in plant community parameters would correspond to changes in the annual rainfall. To reduce the impact of other outside influences and isolate the effects of rainfall, we looked at the response of Wyoming big sagebrush communities protected from livestock grazing since 1936.

Study Sites

The study was conducted at the NGBER in Harney County, located in southeastern Oregon. The experimental range is approximately 40 miles west of Burns, and represents fairly typical vegetation from the Northern Great Basin. The station is jointly run by the USDA-ARS and Oregon State University Agricultural Experiment Stations, and is part of the Eastern Oregon Agricultural Research Center, located in Burns.

Study plots were established in three of the long-term grazing exclosures in a Wyoming big sagebrush/Thurber's needlegrass plant community. Wyoming big sagebrush is the dominant shrub with green rabbitbrush and horsebrush also present in the overstory. Perennial bunchgrasses commonly found are Thurber needlegrass, Sandberg's bluegrass, bottlebrush squirreltail, bluebunch wheatgrass, Idaho fescue, and prairie junegrass. There is a variety of perennial and annual forbs common to the sites. Lupines, milkvetch, and hawksbeard are the most common perennial forbs with allyssum, littleflower collinsia, and microsteris the most common annual forbs.

MATERIALS AND METHODS

Plant community characteristics, aboveground biomass, plant density, and cover were determined in the late spring (May-June) of the three study years. Plant cover was determined on three sites by measuring the intercept of plants along three, 98-foot transects. The number of plants were counted in 10, 2.2-foot-squared plots placed along the 98-foot cover transect. Only plants that were rooted in the plots were counted. Plant aboveground biomass was measured by clipping five of the 2-foot-squared density plots on each transect. Clipped samples were dried and weighed to determine biomass.

Plant cover, density, and biomass information were compared across the 3 years of the study.

RESULTS

Herbaceous Plant Biomass

Total herbaceous plant biomass was greatest in 1993, and least in 1994 (Table 1). Perennial grasses biomass increased by 60 percent from 1992 to 1993. Perennial and annual forb biomass also increased from 1992 to 1993. All three groups had lower biomass values in 1994 than in 1993 or 1992.

Cover

Shrub cover was not different between the 3 years of the study. Cover was dominated by Wyoming big sagebrush, totaling almost 90 percent of the total shrub cover (Table 1). The understory plant cover was dominated by perennial grasses. Total grass cover was greatest in 1993, and similar in 1992 and 1993. Sandberg bluegrass was the species with the greatest cover. Thurber needlegrass and bluebunch wheatgrass were the other two most dominant grasses, and along with Sandberg bluegrass, made up between 75 and 80 percent of the total grass cover in the community. Sandberg bluegrass, Idaho fescue, and prairie junegrass were the only three grasses to increase their cover in response to the additional precipitation in 1993. These three grasses also reduced their cover in 1994 during the dry year. Thurber needlegrass, bottlebrush squirreltail, and bluebunch wheatgrass did not show any consistent response to the precipitation pattern over the 3 years.

Perennial forbs followed the same trend as total grass cover, although total forb cover in 1994 was well below that of 1992 and 1993 (Table 1). Five of the seven species listed had greater cover in 1993 than in 1992 or 1994. The two exceptions were bigseed lomatium and curvepod astragalus. These two species had the greatest cover in 1992. However, neither species was recorded in the driest year, 1993. Menzie's larkspur was also found in 1992 and 1993, but not in 1994.

Plant Density

Total density of grasses was not significantly different between 1992 and 1993, but density was significantly lower in 1994 than in 1992 or 1993 (Table 1). All grasses, with the exception of Idaho fescue, had an increase in density from 1992 to 1993. Density decreased from 1993 to 1994 for all grasses except bottlebrush squirreltail. Sandberg's bluegrass exhibited the greatest reduction in number of individuals, loosing five plants per 10 square feet. Bottlebrush squirreltail actually increased density from 1993 to 1994. This could be attributed to the good growing conditions and a large seed crop in 1993 .

Perennial forb density followed a similar trend to the grasses, but density was slightly higher in 1992 than in 1993 (Table 1). Density dropped significantly in 1994 in response to the dry conditions. Density of pale agoseris was the only perennial forb to significantly respond to increases in annual precipitation. Density of pale agoseris doubled from 1992 to 1993. Lupine was the only perennial forb to have a higher density in 1994 than in 1992 or 1993. Like bottlebrush squirreltail, this may have been due to a large amount of seeds that could have been produced in 1993, which germinated in 1994. Late-winter and spring precipitation was near average for the spring of 1994. Amount and timing of precipitation may have wet the surface layers of the soil allowing germination to occur. Another year's data will be required to determine survival rate.

Annual forbs were the most responsive group to the fluctuation in precipitation. Annual forb density was greatest in 1993, and lowest in 1994. Allyssum, littleflower collinsia, and microsteris are the most common annual forbs found on the plots. All annual forb species increased in density from 1992 to 1993, and decreased from 1993 to 1994. The life history of annual plants allows them to take advantage of good growing conditions when they occur. Annual plants do not have to store food for the winter dormancy. In 1994, Allyssum was the dominant plant in the community, accounting for 35 percent of the annual plant density, 26 percent of total plant density in 1993, 88 percent of all annuals, and 40 percent of all plants in 1994.

Species Diversity

The largest number of species occurred in the wettest year (1993), and the least in the driest year (1994) (Table 1). In these ungrazed communities there was an increase of 11 species from 1992 to 1993, 5 of which were annuals. We recorded six new perennial species in 1993 that were not present in 1992. Species numbers declined by 17 species from 1993 to 1994. This pattern illustrates the influence of annual variation in the plant species diversity in plant communities.

CONCLUSIONS

We found changes in annual rainfall, both in amount and timing, have significant impacts on the plant community dynamics of a Wyoming big sagebrush/Thurber's needlegrass plant community. Responses recorded in 1993 were probably attributed to increases in resources, water, and nutrients. The Experimental Range had experienced 3 years of below-average rainfall before the study started. As seen in this study, drought conditions can have a significant impact on the growth of many plants. This natural variation in the climate may have some important implications for the successional development of these plant communities. The good years may provide pulses of plant establishment, allowing some plant species to gain a foothold in the community. If conditions are good enough for plants to become established, they may be able to hold on and grow during years when resources for plant growth are limited. Dry years may reduce the number of plants in the community and open spaces for new individuals when growing conditions improve. Drought will often kill plants that are weakened by disease, old age, severe competition, or overgrazed. This wet/dry cycle may be a very important process in the ecosystem dynamics of the Wyoming big sagebrush plant communities.

Table 1. Plant biomass, cover and density in a Wyoming big sagebrush plant community across 3 years of different annual rainfall. Northern Great Basin Experimental Range.

	1992	1993	1994	1992	1993	1994
Herbaceous Plant Biomass	lb/ac	lb/ac	lb/ac			
Perennial Grasses	137.5	331.1	101.0			
Perennial Forbs	47.8	68.7	22.2			
Annual Forbs	45.8	99.5	15.6			
	Cover (%)			Density (#/10ft^2)		
Total Shrub	18.9	15.1	19.7	1.2	1.2	1.2
Wyoming Big Sagebrush	17.0	13.5	16.8	0.83	0.83	0.83
Green Rabbitbrush	1.7	1.3	2.6	0.21	0.21	0.21
Total Grasses	6.2	9.2	6.0			
Bluebunch Wheatgrass	0.6	0.9	1.1	1.22	1.72	1.06
Idaho Fescue	1.0	1.4	0.9	1.50	1.44	1.06
Prairie Junegrass	0.1	0.9	0.03	0.39	0.44	0.22
Sandberg's Bluegrass	1.6	3.2	1.6	14.11	14.44	9.17
Bottlebrush Squirreltail	0.3	0.5	0.4	1.06	1.22	2.61
Thurber's Needlegrass	2.6	2.3	2.0	5.56	6.50	4.11
Cheatgrass				0.92	1.30	0.20
Total Perennial Forbs	2.7	3.3	0.9			
Pale Agoseris	0.1	0.3	T	1.61	3.89	1.33
Curvepod Astragalus	0.5	0.3	0.0	1.39	0.83	0.22
Western Hawksbeard	0.2	0.4	0.1	2.67	1.78	1.56
Menzie's Larkspur	0.2	0.5	0.0	2.72	1.28	0
Lupine	0.7	0.9	0.6	0.28	0.83	1.17
Bigseed Lomatium	0.7	0.4	0.0	2.39	1.67	0.17
Longleaf Phlox	0.3	0.5	0.2	4.78	3.56	4.39
Annual Forbs						
Allyssum				19.56	43.39	21.7
Littleflower Collinsia				28.00	44.17	0.72
Pinnate Tansymustard				3.83	5.83	0
Autumn Willowweed				3.78	5.89	0
Microsteris				3.56	17.17	1.22
Species Diversity						
Total Number of Species	34	45	28			

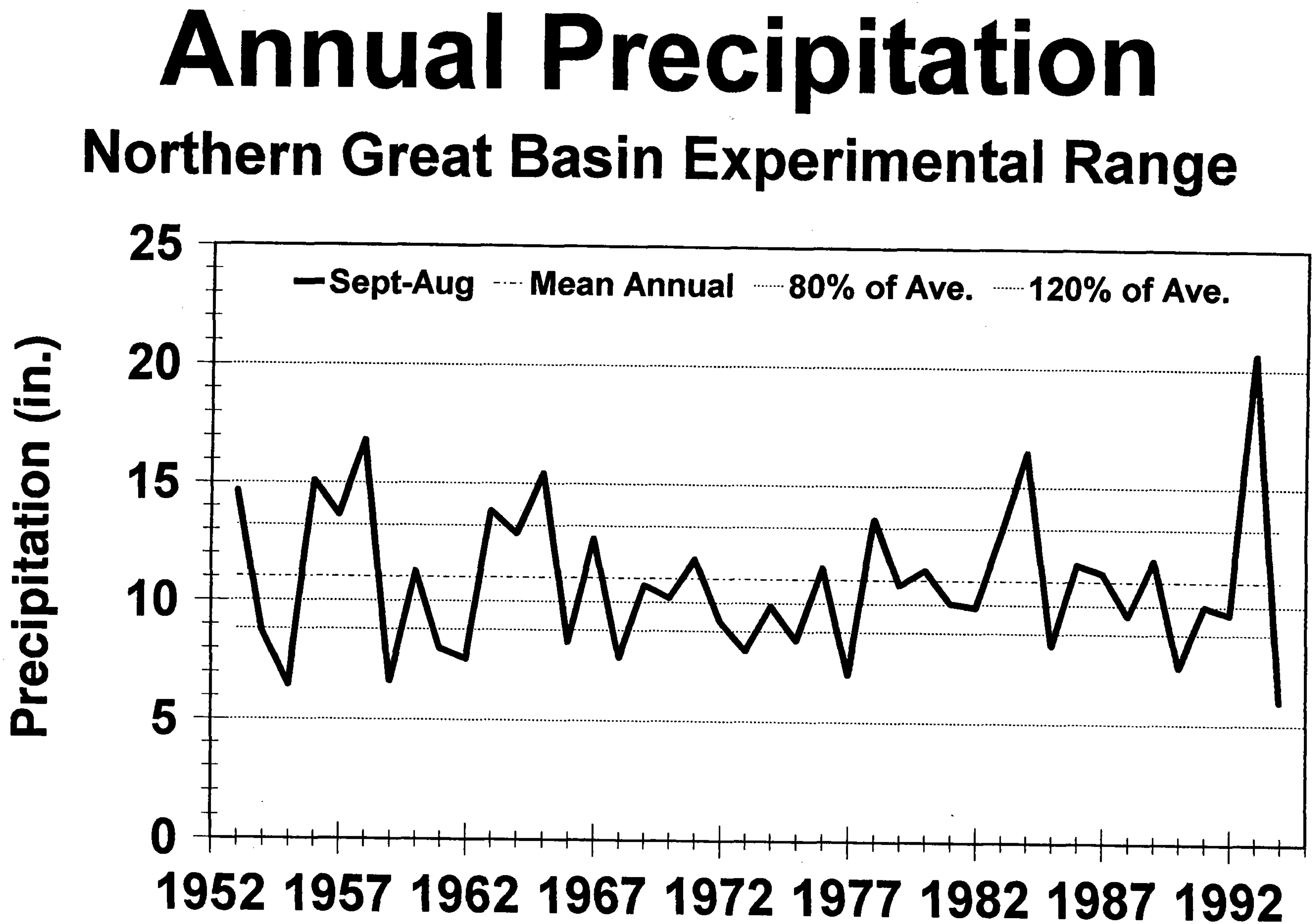


Figure 1. Annual crop year (September thru August) precipitation for the Northern Great Basin Experimental Range, 1952-1994. Short dashed lines are 80% and 120% of long-term average. Dash-dotted line is long-term mean annual precipitation.

Western Juniper Woodland Program

Rick Miller, Tony Svejcar, Lee Eddleman, Jon Bates, Kara Paintner and Jeff Rose

Throughout the west, juniper woodlands have greatly increased in density and distribution. Western juniper (*Juniperus occidentalis*), the northwest equivalent of the pinyon-juniper zone in the Intermountian region, has increased rather dramatically during the past 100 years. Western juniper currently occupies nearly 4 million acres in eastern Oregon, northeastern California, southwestern Idaho, and northern Nevada. It is estimated that nearly 2.3 million acres are located in Oregon. Presettlement juniper woodlands were usually open, savannah-like, or confined to rocky surfaces or ridges. Western juniper began increasing in density and distribution in the late 1800s, primarily invading mountain big sagebrush, low sagebrush, quaking aspen, and riparian communities.

The juniper woodland program at Eastern Oregon Agricultural Research Center (EOARC) has several long-term objectives relating to the ecology, biology, and management of western juniper. Current objectives are:

(1) Identify changes in plant composition and structure and soil characteristics during transition of sagebrush-grassland and aspen communities to juniper woodlands across different soils, climate, aspects, and elevations.

(2) Evaluate the effects of juniper removal on plant community composition, structure, productivity, biodiversity, soil water availability, and soil nutrients across different soils, aspects, and elevations.

(3) Describe juniper age structure, site characteristics, and plant composition of old - growth stands and correlate establishment of old-growth trees with climate.

(4) Develop a classification system for juniper woodlands, using sites in varying states of transition towards juniper woodlands and sites with the potential for invasion.

Currently our study sites are located in Harney and Grant counties in eastern Oregon and Modoc County in northeastern California. However, we hope to expand the juniper woodland program in the future to encompass the majority of this species' range.

SUCCESSION IN WESTERN JUNIPER WOODLANDS:
Soils, woodland structure, and understory response

INTRODUCTION

The overall goals of this study are: (1) to determine what effects increasing juniper has on understory vegetation and ground cover; and (2) evaluate how these changes are modified by such site factors as climate, soils, aspect, elevation, and geology. In addition, we hope to predict the structure and composition of fully developed woodlands on a variety of sagebrush-grassland and aspen sites. We also hope to define the points during transition that thresholds occur (e.g., inability to burn, soil erosion, understory recovery).

Little information exists that correlates soils with western juniper woodlands. Published soil surveys for central and eastern Oregon indicate only the general occurrence of juniper, and only occasional reference is made to the presence of old-growth trees. Western juniper occurs across a wide variety of soils, from shallow heavy clays to deep loams, suggesting that management, site potential, sustainable productivity, growth rates, old growth, and watershed integrity will change across different community types. We also have little information relating such site factors as soils to successional changes that occur during the development of a juniper woodland in shrub bunchgrass or aspen communities. Changes in plant composition and structure will influence such processes as water cycles, nutrient cycles, energy flow; and such site characteristics as productivity, and use by various wildlife species. This study addresses objective number 1: Identify changes in plant composition and structure, and soil characteristics during transition of sagebrush-grassland and aspen communities to juniper woodlands across different climates, soils, aspects, and elevations.

METHODS

Plots were established on Steens Mountain during the summer of 1994. During 1995, work will continue on the Steens and be expanded to northeastern California. Plant community types being studied are mountain big sagebrush, low sagebrush, and aspen with varying levels of juniper density and cover on soils common to these types. Sites are being selected to encompass gradients of elevation, aspect, soil depth, and soil texture. Vegetation and site parameters measured will be juniper, shrub, and herbaceous cover and density, cover of bare-ground, rock, litter, and cryptogams, and soil carbon and nitrogen, as well as elevation, aspect, and slope. Meteorological models will be used to integrate climatic factors with other parameters being measured. Multivariate Analysis will be used to evaluate the influence of site variables and juniper dominance on plant community composition, and total soil carbon and nitrogen.

Plant cover, density, and biomass were measured in permanently marked 60-x-46 meter macroplots. Soil carbon and nitrogen samples will be collected in the A horizon in the shrub and tree interspace on each site. Ten juniper trees (sapling size or greater), that are not competing with neighboring trees, will be cored to estimate growth potential for each site. Samples will be analyzed with a CHN analyzer. A complete soils description will be reported for each site.

RESULTS

We wish to stress these results are based on only one field season and a limited number of sites (29) measured across a variety of site factors. Based on measurements and observations during the 1994 field season, and past work by Miller and Rose (1995), the majority of juniper stands on Steens Mountain are young developing woodlands still in a state of transition. Juniper woodlands on Steens Mountain, generally occur in an elevation belt between 4,700 and 7,000 feet, and can be divided into four zones: (1) mature juniper woodlands, usually found on rocky ridges and low sagebrush tablelands; (2) young woodlands that have recently invaded the sagebrush zone, including mountain mahogany communities; (3) young woodlands that have recently invaded quaking aspen groves; and (4) young woodlands that are invading riparian areas. During the summer of 1994, 29 permanent plots were located within the first three zones to describe community characteristics across different sites and levels of juniper succession. Ten permanent plots were located and described on sites to be cut during the fall of 1994.

Within the three zones, we have tentatively grouped plots into seven community types based on plant species composition, soils, and other site factors (Table 1). We expect woodland structure, plant species composition, response to management, and change of important processes, such as hydrology, to differ across these community types during juniper woodland succession. The greatest loss of understory vegetation occurred on sites where a cemented ash layer (duripan) restricted plant rooting depth to 18 inches. The least impact to understory occurred on the shallow heavy soils on fractured bedrock occupied by very old juniper trees, low sagebrush, and Sandberg bluegrass. A general pattern that occurred across all community types (with the exception for the western juniper/low sagebrush/Sandberg bluegrass type) was the decline in the shrub component as juniper trees increased in density. Across the dry mountain big sagebrush/Idaho fescue type, where juniper canopy cover ranged from 26 to 44 percent, 67 percent of the bitterbrush and sagebrush canopies were dead. On the wetter mountain big sagebrush/Idaho fescue type shrub cover was < 3 percent on sites with > 45 percent juniper cover, compared to sites with > 20 percent shrub cover where juniper cover was < 25 percent. As site potential increased (primarily due to aspect and soil texture and depth), the occurrence of old trees declined and maximum cover and density of young trees increased. Maximum potential tree cover ranged from nearly 20 percent on the shallow heavy soils, to nearly 100 percent on deep loams located on north facing slopes. As our sample size increases across these sites we hope to define thresholds within these communities.

PLANT SUCCESSION FOLLOWING JUNIPER CONTROL

There are few quantitative data on public or private lands documenting changes in plant cover and composition following western juniper removal by cutting or burning. The lack of data limits our ability to plan, predict potential outcomes, determine if objectives were met, and to evaluate the degree of success or failure in juniper removal projects. This information will be critical for effective planning of future juniper management. This study addresses objective number 2: To evaluate the effects of juniper removal on plant community composition, productivity, biodiversity and structure across different soils, aspects, and elevation. Three separate studies have been set up in Grant and Harney counties to measure plant succession following juniper removal. Study sites are located northwest of Mount Vernon and Steens Mountain.

Mount Vernon

The Mount Vernon study is designed to evaluate the effect of juniper cutting on understory plant species composition, cover, and density. Cut trees are left in place. We are also measuring the response of small mammals. The study area is located in a mountain big sagebrush - bitterbrush / Idaho fescue - bluebunch wheatgrass site just below the ponderosa pine forest zone. Two years of plant data have been collected, the year prior and the year following treatment, 1992 and 1993 respectively. A large seed crop was produced in 1993, but 1994 was very dry. Plant species composition will again be measured in 1995. Results have not yet been summarized.

Steens Mountain I

Ten permanent plots were established during the summer of 1994 on Steens Mountain on sites where juniper will be cut. Juniper removal plots range across community types from the western juniper/low sagebrush/Sandberg bluegrass to aspen types. Sites ranged from shallow heavy clay soils to deep loams. On 4 of the 10 sites, paired control plots (junipers will not be cut) were established to compare changes in plant community composition and structure over time between cut and untreated woodland plots. Several more plots will be established on sites to be treated in 1995.

Plant community composition will be monitored both before and after cutting or burning. Plant community composition will be measured no less than every 5 years. Within each treatment area a 60-x- 46 meter macroplot was established. All plant species present within the macroplot are listed for species constancy. Within the macroplot, three permanent 60 meter transects were established. Parameters measured are density and canopy cover of juniper, shrubs, grasses and forbs, cover of cryptogamic crusts, litter, bare-ground, and rock. Site parameters measured are soil depth, texture, C/N, slope, aspect, and elevation.

Understory Plant Succession Following Cutting of Western Juniper

An intensive juniper treatment study was set up in the Cucamonga drainage on Steens Mountain in 1991. The site is dominated by a mature juniper woodland, with dominant trees ranging in age from 70 to 90 years. Soils are predominantly clay loams, about 18-20 inches deep, overlaying a duripan. Juniper canopy cover is approximately 20-25 percent and the density of trees about 95 per/acre. Almost all of the mountain big sagebrush originally on the site was dead. Understory herbaceous basal cover prior to cutting was less than 3 percent, with much of the interspace between trees being bare ground. Herbaceous composition on the site was primarily made up of native perennial and annual species. Bare ground accounted for nearly 75 percent of the area. Rill erosion was evident throughout the site. It is unlikely that this site would have burned even under severe conditions.

METHODS

Eight 2-acre blocks were selected and half of each block (1 acres) was cut in August of 1991. Cut trees were left on site. Plant measurements were recorded in 1991 prior to cutting, and in 1992 and 1993. Measurements will again be recorded in 1995. Measurements included understory plant yield, basal and aerial cover, plant density, species composition, and diversity. Soil moisture throughout the growing season, weather, litter decomposition, C:N, and total N on the site were also measured.

RESULTS

As a general rule, all vegetation components measured showed significant increases following cutting of woodland plots in 1992 and 1993. Climatic conditions in 1992 and 1993 were substantially different. The year 1992 was a drought year and temperatures tended to be higher than average. Growing season (April - July) precipitation in 1992 was 4.5 inches. In 1993, much of eastern Oregon received record levels of precipitation and temperatures tended to be cooler than normal. Growing season precipitation on the site was 10 inches. The following results are from 1993, 2 years following cutting unless otherwise specified.

Plant biomass increased 2.2-fold with cutting, but was still only 40 lbs/ac, compared to 18 lbs/ac on the uncut plots in the first year following cutting (1992) during the drought 1992 year. However, in 1993, the second growing season following cutting understory biomass was over 300 lbs/ac on the cut sites compared to 50 lbs/ac on the uncut sites (fig. 1). Perennial forbs and grasses accounted for 97-98 percent of the total biomass. Annual plant species accounted for only 2-3 percent of the total biomass. Both soil water content measurements and plant water measurements indicated soil water remained available for a longer period, extending the growing season on out plots.

Plant density also increased significantly following cutting. The density of deep-rooted perennial grasses was 0.38 plants per square foot in both the interspace and old-tree canopy zones, three times greater than densities in uncut woodland plots. Perennial forb density increased only slightly following cutting, but plants were larger and produced much greater numbers of reproductive shoots.

Basal and canopy cover of herbaceous plants on cut plots were three times or more greater on the cut plots, as compared to the uncut plots (Fig. 2). Additional protection of the ground surface on the cut plots was provided by the cut juniper trees. The combined cover of cut juniper trees and herbaceous plants was 55 percent, compared to 25 percent on the untreated woodland.

Number of plant species and diversity was higher on cut plots during both years (Table 2). The much wetter conditions during 1993, compared to 1992, probably explains the increased species numbers in both treatments.

OLD GROWTH JUNIPER WOODLANDS

The recent expansion of western juniper woodlands has been well-documented throughout its range. However, we know little about the establishment of presettlement stands still in existence today. The life span of western juniper approaches 1,000 years and the bases of old dead trees can persist for well over 100 years. The overall goals of this project are to describe site characteristics of these old stands and the chronology of tree establishment. Specific questions to be addressed are:

(1) Did presettlement trees establish in pulses (e.g., ages are tightly grouped around certain time periods), or are the ages evenly scattered over time?
(2) Under what kind of climatic conditions did establishment occur?
(3) Are periods of establishment similar across the species range or is there a site effect?
(4) Are tree populations relatively stable on these sites, are they on the decline, or has there been a significant increase in new trees since 1900?
(5) Is the recent increase in juniper individuals a threat to the structure of old-growth stands and health of old trees?

Soils, geology, understory plant communities, elevation, slope, and aspect will be described for these sites. Tree canopy, density, age, and mortality will also be measured. Tree age will be compared to skeleton plots (a composite of tree ring widths) and tree ring chronologies developed for different areas across eastern Oregon and northeastern California to evaluate climatic conditions during establishment.

We hope to continue to add additional plots over the next several years.

RESULTS

Eight plots in old-growth sites were established and described, and one was aged during the summer of 1994. Plots are located in the Devils Plateau in Modoc County, California. Other plots are located on Steens Mountain and the Northern Great Basin Experimental Range (both located in Harney County, Oregon. All sites established were on shallow soils, typically less than 18 inches, overlaying fractured basalt. Soil textures range from clay to silty clay. Plant communities are dominated by low sagebrush - Sandberg bluegrass, with one-spike oatgrass, biscuitroot, wild onion, low pussytoes, hoods phlox, and numerous other forbs commonly associated with the site. Idaho fescue and bluebunch wheatgrass are common directly under the juniper canopy. Rock and bare ground usually account for > 50 percent of the ground cover. These sites, often called juniper tablelands appear to account for a large proportion of the old-growth juniper communities where the soil parent material is composed of basalt. Trees on the site ranged from 200 to 600 years old. It appears that a number of the older trees established between 1400 and 1430 A.D. Densities of old trees ranged from 5 to 25 per acre, and mortality of old trees varied from 8 to 50 percent. Young trees were present on all eight stands, and ranged from 10 to 115 trees per acre. It appeared that juniper densities on five of the eight stands were relatively stable. However, on the remaining three stands, tree densities have significantly increased during the past 100 years.

JUNIPER WOODLAND CLASSIFICATION

This project is in the early phases of development. The long-term goal is to develop a hierarchical classification system for: (1) juniper woodlands, (2) communities in a state of transition towards a woodland, and (3) communities with a high potential for juniper encroachment. The use of this classification system would be to:

(1) Determine the successional status of a given community.
(2) Predict the overstory and understory composition and structure once juniper fully occupies a site.
(3) Determine which plants will likely decrease or disappear as juniper increases.
(4) Define the point at which point-thresholds are reached or crossed (e.g., fire, soil erosion, understory recovery) during transition from shrub-grass or aspen communities to juniper woodlands.
(5) Help land managers prioritize juniper woodland treatments.

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Table 1. Preliminary plant community types and site characteristics of permanent plots on Steens Mountain within the western juniper woodland belt (n=number of permanent plots). 1994.

				SOIL	
SITE	ELEVATION	SLOPE	ASPECT	DEPTH cm	TEXTURE
Aspen (n=3)	5900-6050	10-20	NNE	150-200	Loam (HAPLOBOROLL)
ARTRV/CAREX-STOC (n=0)			NNE	140-200	Loam (HAPLOBOROLL)
ARTRV/FEID mesic (n=4)	5700-6050	9-18	NNE	90-100	Loamy clay (ARGIXEROLL)
ARTRV/FEID xeric (n=11)	5460-6000	3-22	SW	70-135	Loamy clay (ARGIXEROLL)
ARAR/FEID (n=2)	5480-5535	2-4		90-110	Clay (ARGIXEROLL)
ARTRV/STTH (n=2)	5000	5-10	SW	40-60	Loamy clay restrictive layer
JUOC/ARAR/POSA (n=6)	5640-6020	0-3		30-55	Clay (HAPLOARGID)

ARAR - low sagebrush; ARTRV - mountain big sagebrush; FEID - Idaho fescue; JUOC - western juniper; POSA - Sandberg's bluegrass; STOC - western needlegrass; and STTH - Thurbers needlegrass.

Table 2. Number of species of various plant growth forms in cut and woodland juniper plots. Steens Mountain, 1994.

	1992		1993	
Growth Form	Cut	Woodland	Cut	Woodland
Perennial Grass	8	6	8	6
Annual Grass	2	1	2	2
Perennial Forb	11	3	17	7
Annual Forb (native)	9	4	10	7
Annual Forb (alien)	5	1	8	3
Total	35	16	45	25
Hill #1 Diversity Index	6.0	3.4	7.7	4.3

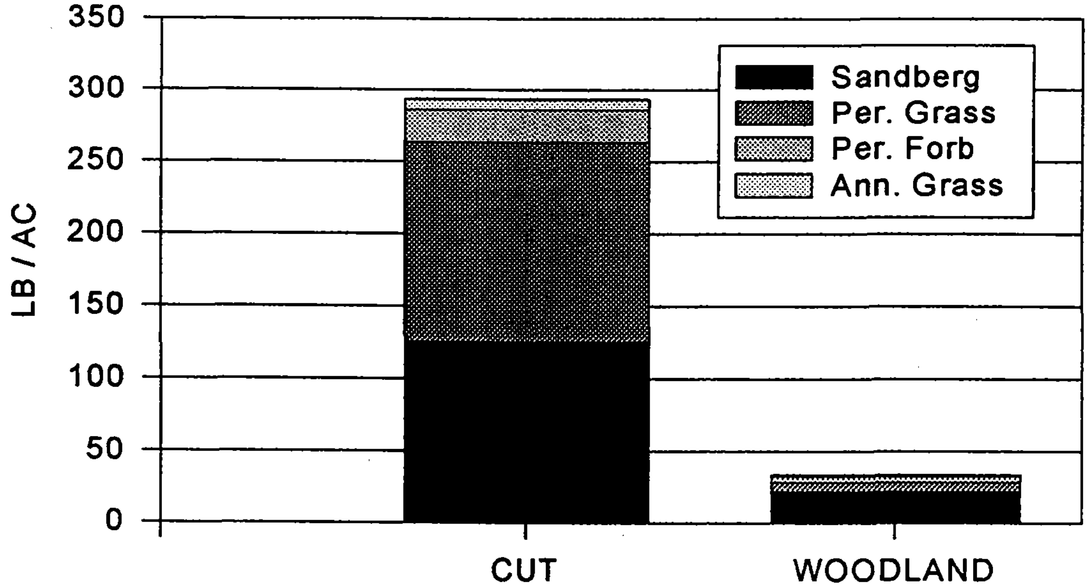

Figure 1: Biomass Production, 1993.

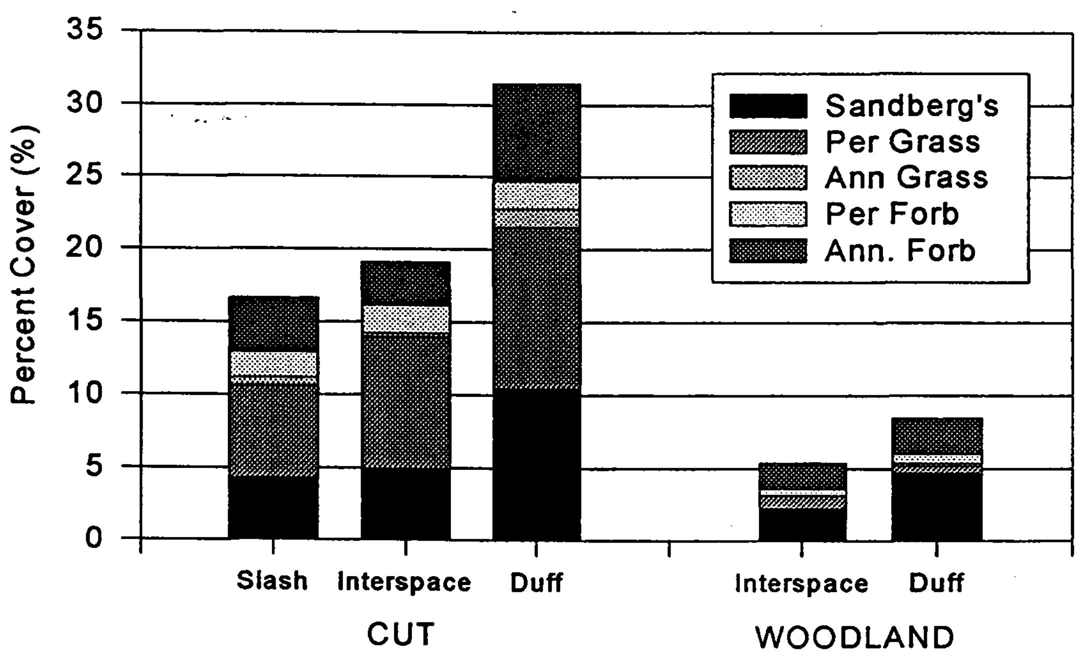

Figure 2: Understory Canopy Cover
Steens Mountain, 1993.

Drought Effects on Southeast Oregon Native Meadows

Ray Angell, Dave Nixon, and Roxane Barton

SUMMARY

Meadow foxtail (*Alopecurus pratensis* L.) is a highly productive grass introduced from temperate regions of Europe and Asia that has increased in density and gained dominance in many native meadows in southeast Oregon and elsewhere. Native meadows in this region are critical as a forage and hay base for commercial beef production, and their importance will increase as livestock operators search for alternatives to public land grazing. This study was established to investigate the response of meadow foxtail and associated native species to drought. In the third year of a drought, plots were established on meadow dominated, prior to the drought, by meadow foxtail. The first year (1992) was dry with snowpack at 25 percent of average, whereas in 1993, snowpack was 50 percent above average. Foxtail yield in ungrazed plots was 230 and 5,518 lb/ac in 1992 and 1993, respectively. Meadow foxtail provided 68 and 76 percent of total herbaceous production in 1992 and 1993, respectively. Botanical composition was dominated by foxtail both years at 71 and 53 percent, respectively, in 1992 and 1993. Basal cover of meadow foxtail more than doubled after the drought. We conclude from these data that meadow foxtail is persistent under severe drought conditions, and that stand deterioration is not likely.

INTRODUCTION

Native flood meadows of eastern Oregon are classified as seasonally wet because of early spring snowmelt. Historically, the forage was composed of native grasses including Nevada bluegrass (*Poa nevadensis* Vasey ex Scribn.) and beardless wildrye (*Elymus triticoides* Buckl.), rushes (*Juncus* spp.), sedges (*Carex* and *Eleocharis* spp.), and a variety of forbs.

During the past 20 years an introduced species, meadow foxtail (*Alopecurus pratensis* L.), has increased area of coverage in native meadow systems, producing almost monospecific stands in some localities. Yield and forage quality are high, and with nitrogen fertilization foxtail yields can equal or exceed those of timothy (*Phleum pratense* L.), orchardgrass (*Dactylis glomerata* L.), or smooth bromegrass (*Bromus inermis* Leyss.).

Development of new management strategies for these meadows requires quantitative information regarding response to drought. This study was established in the third year of an intense drought with the objective of determining the effect of drought on native meadow botanical composition, basal cover, and forage yield.

MATERIALS AND METHODS

The study was conducted at the Eastern Oregon Agricultural Research Center (EOARC), about 5 miles south of Burns, Oregon. Meadow foxtail dominated the stand prior to the drought. Mean annual precipitation (30 year mean) is about 11.8 inches, primarily as winter snow. Our study site was a 57-acre native flood meadow in which eight 82-x 164-foot experimental plots were established in four blocks along an elevational gradient to account for elevation effects on flooding depth and duration. In each block one plot was fenced with electric fence to prevent grazing, creating two treatments in four blocks.

In May 1992, a permanent 160-foot line transect was established diagonally across each plot. Steel pins were placed at ground level to permit relocation in 1993. Forage yield was estimated each year by placing 10 frames at 15-foot intervals and clipping forage to ground level. Forage was separated into meadow foxtail, sedge/rush, other grasses, and forbs, then dried and weighed. Clipping was done in mid-July, corresponding to traditional haying dates.

Botanical composition and basal cover were estimated by modified step-point, with 200 points recorded in each plot. Data were separated into five categories: meadow foxtail, sedges, rushes, other grasses, and forbs. Sampling was performed over 3 days beginning July 9, just prior to clipping. Meadow foxtail forage from the clipping study was ground through a 1 millimeter screen and stored in plastic bags. Organic matter, ash, digestibility, and protein content were determined for each sample.

Drought restricted grazing in 1992, however eight steers were released on the pasture May 1 and were allowed to graze for 1 week. Forage yield in 1993 was excellent and 84 yearling heifers were released to graze on May 3. Cattle remained on pasture until the study was terminated July 19, 1993. Cattle had equal access to each of the four blocks, and in both years visual observations indicated that they spent similar amounts of time grazing in each block.

RESULTS

Precipitation

In this part of the Northern Great Basin precipitation usually peaks in January, with another small peak in May and June (Figure 1). September-August precipitation was 8.7 and 13.7 inches in 1991-92 and 1992-93, respectively. December and January were, respectively, 16 and 10 percent of average in the 1991-92 crop year, resulting in below-normal snowpack. No surface water was available in 1992 to provide irrigation to experimental plots, while in 1993 surface water was present from April through June. The only significant precipitation events during the 1991-92 season occurred in June, 1992, when 77 millimeter rain fell.

Yield

Total yield in ungrazed plots was significantly higher in 1993 than 1992 for all categories of plants (Table 1). During the drought of 1992, locust infestation was heavy. We noted that grasshoppers consumed primarily meadow foxtail leaf and sheath, based on visual observation. Grasshopper damage was extensive during the drought, and significantly affected yield estimates of meadow foxtail in 1992.

June, 1992, rainfall was three times normal and occurred during the normal peak growth period. We found that while meadow foxtail can produce growth after spring rain, yield will be significantly reduced without surface irrigation. Even with the high June precipitation amounts, ungrazed yields were only about 5 percent of average for this site in 1992.

The 1993 growing season allowed us to measure plant growth and development under ideal conditions; crop-year precipitation was 15 percent above average, and snowmelt provided irrigation for about 6 weeks beginning in early May. Even after 3 years without irrigation, yields in 1993 approached pre-drought 1989 values, at about 7,294 and 8,277 lb/acre, respectively.

In ungrazed plots, meadow foxtail contributed 68 percent of total yield in July, 1992, significantly less than in 1993 (Table 2). Meadow foxtail clearly remained the dominant forage species in these meadows following a 3-year drought, with percentage yield comparable to 1989.

Composition and basal cover

Botanical composition of ungrazed meadow in 1992 further illustrates the dominance which meadow foxtail has gained in these meadows (Table 3). Together, foxtail and sedges accounted for 85 percent of the composition. The following year, 1993, foxtail percentage declined significantly in response to significant increases in rush and other grass categories. Grazed plots exhibited a similar trend, however the greater regrowth potential of meadow foxtail allowed it to maintain its place in the stand. Earlier work on the same pasture found that steer diets in June were dominated by sedges and rushes. We speculate that in this study relatively greater pressure was probably placed on sedge and rush components during grazing in June. That would accentuate the differences noted, because sedge/rush species common to these meadows have limited regrowth potential.

Basal cover increased in the wet year, however the only plant category to show a significant change was meadow foxtail (Table 4). Basal cover of ungrazed meadow foxtail increased 3 percent between 1992 and 1993, while all other categories remained at or below 1 percent. Meadow foxtail on grazed plots tended to increase while other categories were minor components both years.

Meadow foxtail quality

Meadow foxtail IVOMD for hand-clipped samples was greatest in July, 1992 (Figure 2). Plants did not grow to maturity that year, but became quiescent during the late vegetative to early flowering stage of growth. Grazed and ungrazed plots did not differ for CP or IVOMD in 1992, however grazing increased forage quality in July, 1993. Regrowth after grazing raised IVOMD and CP by about 9 and 7 percent, respectively.

Crude protein was very high in 1992, at about 27 percent in both treatments, evidently enhanced by the early cessation of growth that year. Ungrazed plants grew to maturity in 1993, and protein levels in July had fallen to only 5 percent. This drop in quality is probably a result of advanced maturity and dilution of high-nitrogen cell constituents by low-nitrogen cell wall components. Increased cell wall content likely contributed to the measured drop in IVOMD.

CONCLUSION

Meadow foxtail is a species well adapted to wet, saturated conditions. It is not native to the high-elevation meadows of the northern Great Basin, however it has shown significant local increases in meadows such as those in the Harney Basin. After a 3-year drought during which no surface irrigation occurred, it maintained its presence in the stand and when released from the drought produced yields comparable to pre-drought levels. It clearly did not decrease significantly due to drought effects. Botanical composition and cover data show that it was able to survive the drought, and provide no indication of significant death loss during the drought. We reject the hypothesis that drought will kill meadow foxtail and decrease its dominance in the stand. These data point to the fact that meadow foxtail is well-adapted to environmental conditions in the northern Great Basin and that it is likely that it will continue to expand its coverage and dominance in those meadows to which it is adapted. In light of this, additional research is warranted to determine the best management strategies for meadows which become dominated by this species.

Table 1. Forage DM yield (kg/ha) of meadow foxtail, sedges/rushes, other grasses, and forbs in grazed and ungrazed plots at EOARC during 1992 and 1993.

	Ungrazed		Grazed	
Species	1992	1993	1992	1993
Meadow foxtail	257	6184*	274	1014
Sedges/Rushes	29	967*	5	89
Other grasses	36	614*	12	9
Forbs	69	430*	35	57

* Species means between years are significantly different (P<.05).

Table 2. Forage DM yield (% of total) for meadow foxtail, sedges/rushes, other grasses, and forbs in grazed and ungrazed plots at EOARC during 1992 and 1993.

	Ungrazed		Grazed	
Plant Category	1992	1993	1992	1993
Meadow foxtail	68	76*	85	83
Sedges/rushes	8	12*	2	9
Other grasses	9	6	4	2
Forbs	16	5*	9	7

* Species means between years are significantly different (P<.05).

Table 3. Composition of forage (%) on an eastern Oregon flood meadow during a drought (1992) and a wet (1993) year.

	Ungrazed		Grazed	
Species	1992	1993	1992	1993
Meadow foxtail	71	* 53	91	82
Sedges/Rushes	14	10	4	2
Other grasses	6	* 20	2	* 12
Forbs	4	* 13	2	3
Total yield	5	5	2	1

* Species means between years are significantly different (P<.05).

Table 4. Basal cover (%) for major plant categories on grazed or ungrazed eastern Oregon native meadows at EOARC during drought (1992) and wet (1993) years.

	Ungrazed		Grazed	
Plant Category	1992	1993	1992	1993
Meadow foxtail	2	* 5	2	4
Sedges	<1	1	0	0
Rushes	<1	1	0	1
Other grasses	<1	1	0	<1
Forbs	<1	1	1	<1

* Species means between years are significantly different (P<.05).

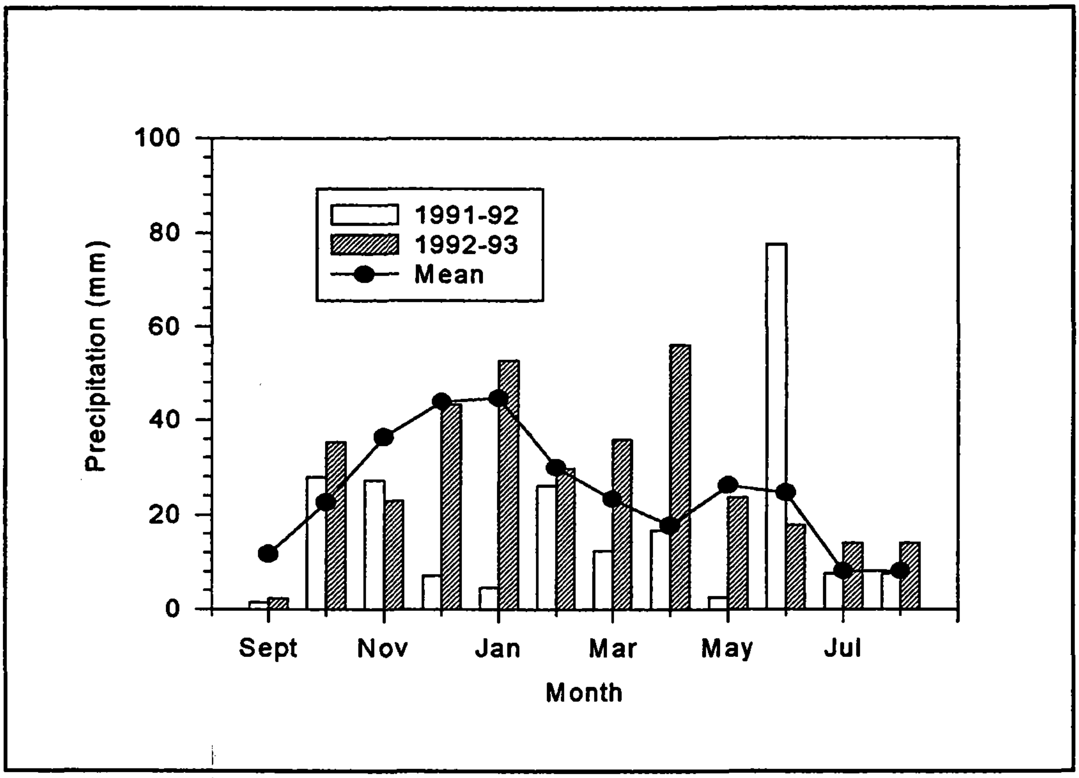

Figure 1. Precipitation amounts for 1992 and 1993 compared to the 30-year average at Burns, Oregon.

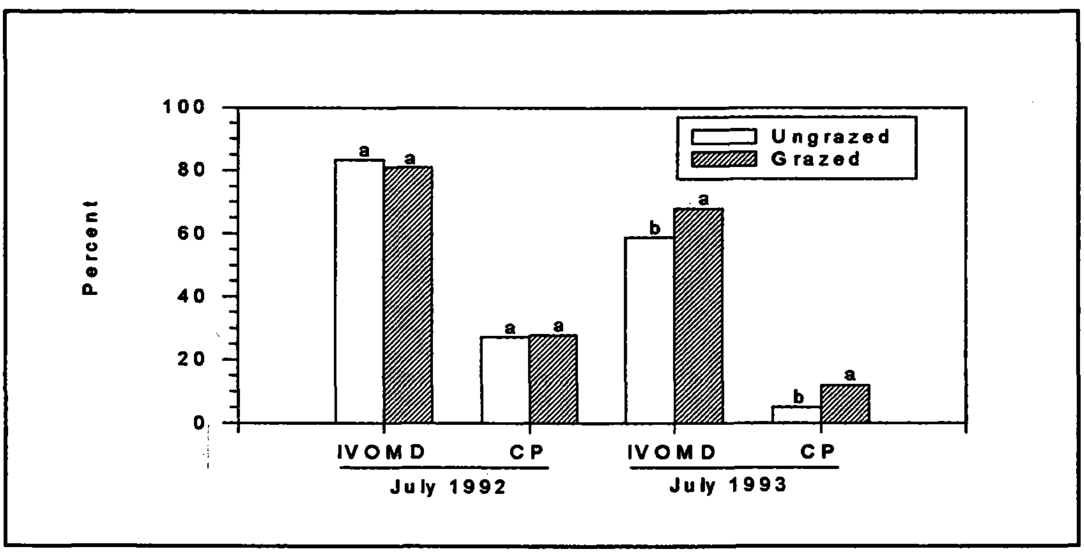

Figure 2. In vitro organic matter digestibility and crude protein of meadow foxtail clipped in July 1992 and 1993 at the Eastern Oregon Agricultural Research Center.

Enhancing Upland Rangelands to Mitigate Impact of Ungulate Grazing on Critical Watersheds

Dennis P. Sheehy, William Krueger, and John Williams

SUMMARY

This study is being initiated at the request of the Wallowa County Cattleman's Association to address an on-going conflict over use of privately owned seasonal rangeland by wild ungulates. The Oregon Department of Fish and Wildlife will be the primary cooperating agency in the study. The study will also provide information of relevance to the Wallowa County Salmon Recovery Plan, and assist in defining methodology to enhance upland and stream habitat on grazed seasonal rangeland.

INTRODUCTION

The study location is Wallowa County of northeastern Oregon. Specific project areas are privately owned seasonal rangeland in the Big Sheep Creek drainage of the Imnaha River watershed, Chesnimnus Creek drainage of the Joseph Creek watershed, and Eden Bench of the Grande Ronde River watershed.

Seasonal rangeland uplands of the three drainages are grazed by wild and domestic ungulates. Generally, uplands are grazed by elk in late-winter/early spring prior to late-spring and summer use by cattle. Cattle and elk often graze the same upland areas during the fall. The problem as perceived by the landowners is late winter/early spring grazing by elk occurs at the time that soils and vegetation of upland plant communities are most susceptible to the destabilizing effects of ungulate grazing. Early season use of upland bunchgrass communities is also perceived as significantly decreasing summer forage production needed for optimal livestock production, often forcing the landowner to make less than optimal grazing management decisions.

Less than optimal grazing management decisions have the potential to affect stream habitat critical to other animal users, especially fish and aquatic animals. Suitable stream condition depends on conditions throughout the watershed, not just in the stream corridor itself. Impacts of over-grazing by ungulates may be manifested through declining ecological condition of upland vegetation and soils. This often leads to an increase in upland soil erosion, a decrease in upland soil water-holding capabilities, and an increase in water run-off. These processes associated with uplands influence the general health of the stream corridor and the maintenance of suitable spawning and rearing habitat for salmonid and other aquatic species. Improved grazing management strategies for ungulates on uplands, as well as directly in the stream corridors, presents opportunities to address ungulate grazing conflicts and reduce the potential for ungulate grazing impacts on uplands to be transferred to the stream corridor itself.

Study objectives are: 1) to enhance forage and improve animal distribution to mitigate the on-going conflict over use of privately owned seasonal rangeland by Rocky Mountain Elk and 2) to implement ungulate grazing management strategies (timing and distribution of ungulate grazing, fertilizer applications, fencing, off-stream water development, etc.) for upland bunchgrass rangeland that will enhance fish spawning and rearing habitat in streams draining uplands in the watershed.

MATERIALS AND METHODS

Indicators of ecological stability monitored will include: 1) current vegetation composition and structure; 2) current vegetation yields under grazing by elk only, by cattle only, and by elk and cattle; 3) soil compaction and erosion; and 4) stream water quality.

In March, 1995, vegetation macro-plots (0.1 acre) will be established on the three high- intensity ungulate use areas. Between spring, 1995, and November, 1997, the following information will be obtained from the vegetation-soil macroplots between the onset of elk use in the spring, and the end of cattle use in the fall:

1. monthly recording of macroplot soil and vegetation attributes including evidence of animal trampling and soil compaction, seasonal development of vegetation, and soil stability;

2. yields of vegetation under the different ungulate grazing treatments will be determined from small exclosures established on each macroplot;

3. stream reaches potentially receiving run-off from the affected upland areas will be sampled at bi-weekly intervals between onset of elk grazing on the uplands and cessation of cattle grazing in the fall to determine water temperature, turbidity, oxygen, and pH as indicators of soil and vegetation instability in associated upland areas impacting stream condition.

DISCUSSION

The project will determine if the timing and intensity of current multi-ungulate grazing is adversely affecting stability of uplands in the watershed of streams containing critical salmon spawning and rearing habitat. This would involve ecological monitoring of ungulate grazing impacts on upland areas receiving high-intensity multi-ungulate grazing, and monitoring of upland grazing impacts on stream condition.

Recommendations for long-term mitigation needed to maintain ecological stability of grazed bunchgrass uplands will be made. These will include an assessment of the ecological and economic feasibility of using periodic application of short-term treatments, a reduction in wild ungulate grazing by reducing ungulate numbers and/or changing distribution and behavior, and adopting management strategies for one or both ungulate species that maintain upland ecosystem stability.

Monitoring will continue during and after treatment application to obtain information for analyzing treatment success. Success will be determined by measuring the response of soils and vegetation in the macroplots to the treatment(s).

Ungulate Management to Enhance a Grazed Seasonal Rangeland Ecosystem

Dennis P. Sheehy

SUMMARY

Seasonal rangeland in the lower Hells Canyon provides forage for domestic and wild ungulates during the winter and spring. Preliminary information suggests that grazing by cattle improves forage quality for wild ungulates, especially Rocky Mountain elk. Although cattle and elk may have a synergistic relationship, the impact of several ungulates on ecological stability of grazed plant communities needs to be determined in greater depth.

INTRODUCTION

Seasonal and winter rangeland is a complex of vegetation and terrain features providing forage for large ungulate grazers during a critical period in the yearly grazing cycle. Rocky Mountain Elk *(Cervus elaphus nelsonii)*, mule deer *(Odocoileus hemionus hemionus)*, and bighorn sheep (*Ovis canadensis*) use seasonal rangeland in late autumn and early spring. Although most livestock use seasonal rangeland as transitional range in late spring and early fall, lower-elevation seasonal rangeland and winter rangeland, if available, is also used for winter grazing by cattle and sheep.

In northeastern Oregon, the impact of livestock grazing on biological resources is being increasingly scrutinized by the general public. Livestock producers feel that large wild ungulates often compete with livestock for forage on publicly and privately managed seasonal and winter rangeland (Sheehy 1988, Vavra 1980). Also, a major concern of environmental groups is that biological resources of environmentally sensitive seasonal rangeland are being diminished by livestock grazing, and that livestock grazing should be eliminated or restricted.

The conflict over allocation of grazing resources between large domestic and wild ungulates has been long-standing and usually adversarial in context. However, recent concern over the impact of ungulate grazing in general on habitat used by threatened and endangered species has placed ungulate grazing in a new context. If cattle grazing improves the quality of seasonal rangeland forage available to elk during critical periods of nutritional stress, then removal of cattle from publicly managed seasonal rangeland will lower the forage quality for elk and cause them to concentrate foraging activities on seasonal rangeland that continues to be grazed by cattle, i.e., privately owned seasonal rangeland. Privately owned seasonal rangeland often contains stream and riparian habitat important to many species of fish and wildlife.

The study seeks to provide more information on: 1) the role of livestock in improving forage condition for wild ungulates on winter and seasonal rangeland, especially the role of cattle in conditioning forage; 2) the response of bunchgrass communities to timing of grazing, grazing intensity, and grazing by several ungulates; and 3) ungulate grazing management strategies that enhance ecological stability of private and public rangeland.

METHODS AND MATERIALS

Ecological Site Measurements

Replicated transects to measure vegetation and soil parameters of plant communities comprising seasonal rangeland have been established in each grazing allotment. Along each general transect line, 20-square-meter macroplot sites situated according to differences in elevation, aspect, and vegetation type were established. Terrain features (slope, aspect, elevation, and slope position) at each macroplot were recorded. Measurements of vegetation in the macroplot are obtained from 10, 0.2-square-meter micro-plots placed along a 20-meter plot transect line at 2-meter intervals. Movable net wire exclosures (1.0-square-meter) have been placed on each macroplot and used to determine plant phenology, growth curves, and standing crop of vegetation. Standing crop of plant species in each macroplot are harvested from 0.25-square-meter paired plots (protected and unprotected by the exclosure) at intervals determined by the presence of livestock in each allotment.

Ungulate Diet Selection.

Fecal samples from each ungulate species are collected at bi-weekly intervals while the animals are in each allotment of the study area. These samples are used to determine composition of ungulate diets and ungulate diet quality (crude protein and digestible dry matter) obtainable from grazed and non-livestock-grazed allotments. Crude protein content and digestible organic matter (DOM) of vegetation forming ungulate diets is determined at bi-weekly intervals using Near Infra-Red Spectrometry (NIRS) procedures for fecal profiling to determine an index of ungulate diet quality (Stuth and Lyons 1992). A sub-sample of fecal material collected from ungulates in each allotment is analyzed.

RESULTS

Forage Availability.

During winter and spring, cattle and wild ungulates graze the same seasonal rangeland in the lower Hells Canyon. Consequently, availability and quality of forage that is available are important constraints influencing economic survival of the rancher, and also viability of wild ungulate populations.

The study area has three separate management units (breaks, benches, and river) that are grazed by livestock at different times during the winter. The breaks, which are seasonal rangeland at higher elevation, are grazed by livestock between November and January, and again in late April and May after calving. The benches are medium-elevation seasonal rangeland grazed by livestock from late January to late February. The management unit contains the benches and lower-elevation seasonal rangeland along the Imnaha River that are grazed in March and April during which calving occurs. Approximately 800 elk also graze the "breaks" during winter and spring. Forage standing crop on the three management units is diverse (Table 1).

The quantity of forage standing crop is highest in the breaks. If new growth of forage indicates higher nutrient availability, forage standing crop in the breaks also has higher nutrients available than either the "benches" or the "river" management units during winter. The data samples suggests that plant communities in the "breaks" provide high-quality forage for both cattle and elk, at least compared to the forage available on the "benches," and even more so compared to forage that would be available to cattle or elk during the winter in the "river" management unit.

Table 1. Forage standing crop (g/0.25 m^2 D.w.) on three-management units grazed by domestic and wild ungulates in the lower Hells Canyon.

	Grass			Forb			Total		
	Tot	New	Old	Tot.	New	Old	Tot.	New	Old
Breaks 4 (NW)	120.4	27.4	93.0	6.0	0.8	5.2	126.4	28.2	98.2
1 (S)	140.3	42.7	97.6	13.4	4.7	8.7	153.7	47.3	106.3
1 (SE)	60.0	4.7	55.3	0.5	0.0	0.5	60.1	4.8	55.3
6 x	113.7	8.2	87.5	6.3	1.3	5.0	119.9	27.5	92.4
Bench 3 (SE)	147.0	11.2	135.8	1.8	0.6	1.2	148.6	11.8	137.0
2 (SW)	52.4	5.2	43.8	3.4	0.0	3.4	52.4	5.2	47.2
4 (NW)	66.6	15.3	51.3	5.4	0.5	4.9	72.4	15.8	56.6
1 (S)	123.8	18.1	105.7	5.2	0.0	5.2	129.8	18.1	111.7
1 (N)	36.3	10.2	26.1	0.6	0.0	0.6	36.9	10.2	26.7
11 x	88.4	12.1	75.6	3.6	0.3	3.3	91.5	12.4	79.1
River 3 (S)	59.0	2.0	56.6	8.2	0.0	8.2	67.2	2.8	64.5
1 (S)	81.0	5.0	76.0	3.4	0.0	3.4	90.4	8.0	79.4
1 (SW)	91.0	3.1	87.9	2.2	0.0	2.2	95.4	5.3	90.3
2 (N)	69.4	22.4	47.0	3.0	0.0	3.0	72.4	22.6	50.0
1 (NE)	83.4	5.0	78.4	9.6	0.0	9.6	93.0	5.0	88.0
1 (NW)	59.0	8.9	50.1	8.1	0.0	8.1	67.1	8.9	58.2
9 x	70.0	8.2	61.8	6.0	0.0	6.0	76.9	9.0	67.7

Winter Range Nutrient Availability.

Fecal profiling of livestock using near infrared spectroscopy technology allows prediction of dietary crude protein (%CP), and digestible organic matter (%DOM) on a dry-matter basis is a developing technology of the Grazing Animal Nutrition Laboratory at Texas A&M University. The information collected in this study will facilitate development of predictive equations for Rocky Mountain elk, mule deer, and bighorn sheep.

Table 2. Near Infra-Red Spectroscopy (NIRS) values for crude protein (CP) and digestible organic matter (DOM) in the diets of large ungulates using winter and seasonal rangeland lower Hell's Canyon. Elk diets were estimated using cattle equations; deer and bighorn sheep using goat equations.

	CATTLE		ELK		DEER		BIGHORN	
Date	CP	DOM	CP	DOM	CP	DOM	CP	DOM
12-92	3.83	50.37	4.75	53.42				
1-93	3.69	49.71	5.59	51.63				
2-93	4.85	49.24	5.04	51.97	6.54	51.01	7.45	53.26
5-93			14.40	61.65				
6-93			15.64	61.66				
10-93					7.27	55.84		
12-93	5.72	53.90					7.46	53.45
1-94	4.22	52.07			3.08	50.58		
2-94	5.13	54.17	4.15	49.75				
3-94	4.66	50.86			6.23	51.79	7.97	52.92

Cattle on the McClaran winter rangeland have an obvious crude protein and digestible organic matter deficiency during the winter because of the low quality of forage standing crop available to them during the winter months. The data suggests that forage standing crop had higher CP and DOM levels in 1994 compared to 1993. This prediction is consistent with field observations of forage standing crop, which during the winter of 1992-1993, appeared to be highly leached and poorly cured. Record spring-summer precipitation was received during summer, 1992. This caused record levels of forage production on seasonal and winter ranges that possibly had low nutrient levels and cured poorly.

The level of CP and DOM available to Rocky Mountain elk from the same seasonal/winter range increased dramatically between the winter months and late spring, even though the values obtained from NIRS cannot be used to directly predict levels of CP and DOM in elk diets. The data does suggest that elk had approximately three times the amount of crude protein in their diets in the spring as during the winter. The data also suggests that the level of available DOM from forage was significantly higher in the spring than in the winter. The data suggests that bighorn sheep and mule deer were able to maintain higher levels of CP and DOM in their diets during the winter than cattle or elk.

DISCUSSION

It is not clear what impacts current levels of domestic and/or wild ungulate grazing are having on ecological stability and secondary succession of vegetation comprising the seasonal rangeland plant communities used for winter grazing. A primary concern of resource managers is maintaining or enhancing ecological stability of vegetation that comprises the forage resource for ungulate grazers.

A synergistic relationship does exist between ungulate grazers, whereby one ungulate species improves forage quantity and quality for a second ungulate species. It is possible that removal of one ungulate grazer will alter behavior and/or distribution of the other. Such alteration could locally increase herd sizes to the point that community stability is decreased and intra-specific competition is increased. Although the sample data does not address it, another important question that must be addressed is the impact of ungulate grazing on ecological stability of plant communities, especially on plant communities receiving grazing by more than one ungulate.

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Calibrating Nutrient Content of Elk Diets Using Near Infra-Red Spectroscopy (NIRS) Techniques

Dennis P. Sheehy

SUMMARY

Captive elk were fed rations of known nutritive quality to develop a predictive equation for determining crude protein (CP) and digestible organic matter (DOM) through fecal profiling. Near infra-red spectroscopy (NIRS) techniques have been developed that allow the actual nutrient level of a herbivore's diet to be estimated. Developing and validating the predictive equation for elk would allow for improved management of livestock and elk using the same seasonal rangeland.

INTRODUCTION

A technique for predicting levels of CP and digestible dry matter (DDM) in the diets of grazing animals has been developed by the Grazing Animal Nutrition Laboratory at Texas A&M University. Nutrient content is predicted by relating reflected /absorbed chemical bonds in feces to known values of CP and DDM in the ration fed to the animals. Chemical bond values are used to generate a predictive calibration set for the spectrometer.

Currently, predictive calibration data sets have been established only for free-ranging cattle and goats. However, the Dubois Sheep Experiment Station (USDA-ARS) is initiating a study to develop a predictive calibration data set for domestic sheep. The Eastern Oregon Agricultural Research Center (EOARC), Range and Wildlife Habitat Laboratory (USDA-Forest Service), National Council of the Paper Industry (NCASI), Oregon Dept. of Fish and Wildlife (Research Unit), and the Grazing Animal Nutrition Laboratory (Texas A&M University) are collaborating in developing a predictive calibration data set for Rocky Mountain Elk (*Cervus elaphus nelsonii*).

MATERIALS AND METHODS

A minimum of 30 samples, and ideally at least 50 samples, are required to create a NIRS predictive equation. In the preliminary study, 55 fecal samples were collected. Twenty-five composite fecal samples in trial number 1 were obtained from five groups of elk. They were fed 5 rations that differed by feeding level, quality, and age of animal with samples collected over 5 successive days. Thirty composite fecal samples in trial number 2 were obtained from two groups of elk fed five rations that differ by quality, with three collections at 2-day intervals.

Starkey Feed And Animals

Six adult female elk on the Starkey Experimental Area were separated into three groups of two animals each. They were fed the following: two quality levels of alfalfa hay (very high quality at 21 percent CP, and high quality at 16 percent CP); grass hay at three quality levels; and low-quality grass seed straw. All hay rations were chopped to equal-length fragments. Elk in the Starkey feeding trial were fed high-quality alfalfa hay as their normal diet. High- and medium-quality grass hay were obtained locally (Union Co.) with selection based on uniformity of species composition. Higher-quality grass hay was a mixture of timothy, bluegrass, and meadow foxtail, which are well established forage and hay species in northeast Oregon. The low-quality rations were orchard-grass hay that over-matured prior to harvest, and grass seed straw from the Willamette Valley.

Hay or pellets not consumed during each feeding trial were removed from the pen at the conclusion of each trial. All feed not consumed or used during the feeding trials was removed from the Starkey Experimental Area at the conclusion of the feeding trials. Rations were fed *ad libitum* to trial animals from feeders.

Kamela Feeds And Animals.

Elk at Kamela were fed *ad libitum* a prepared ration consisting of a known quantity and quality of alfalfa hay, and a pelleted ration mix at different intake levels. In these feeding trials, the exact amount of feed provided was known. Elk were separated into five groups consisting of three groups of mature cows, and two groups of calves.

Table 1. Kamela elk feeding regimes.

Ration Quality[a]	Feeding Level[b]	Age Class	No.
High	Ad libitum	Adults	6
High	Ad libitum	Calves	6
Medium	7% MW	Calves	12
Low	6% MW	Adults	6
Low	9% MW	Adults	6

[a]High = 14-16 % crude protein, 68% IVDDM; Medium = 12-14 % crude protein, 62% IVDDM; Low = 14-16 % crude protein, 53% IVDDM

[b]The 6% and 7% feeding levels are highly submaintenance. The 9% feeding level is roughly at maintenance, based on weight dynamics. Elk on the ad libitum diet are consuming about 11% MW.

Feeding Trials

Each feeding trial was carried out over a 15-day period. Animals in each group (both Starkey and Kamela) were allowed access to the ration for a minimum of 10 days prior to collection of fecal samples. Three fecal samples were collected following the 10-day feed adaptation period (collection on day 11, 12, 13) for a total of three samples per trial group. A composite sample consisted of an equal weight of fecal material (4-6 pellets) collected from 5 to 10 fecal deposits composited by collection day across animals in the feeding trial. Samples represented a composite of elk consumption during the previous 48 hours. Fecal sample composites were collected in a plastic "ziploc" bag, approximately 1 quart in volume, and frozen as soon as possible following collection.

RESULTS

Frozen fecal and ration samples were sent to the Grazing Animal Nutrition Laboratory, Texas A&M University, for NIRS analysis. Data analysis will be similar to analysis of data used to develop predictive equations and calibrate NIRS for cattle and goats. A "grab" sample of each hay or pellet ration is being analyzed to determine pre-ingestion levels of CP and DDM. A second grab sample obtained from orts of each ration will be analyzed for levels of CP and DDM. Differences will be used to calculate actual CP and DDM of the ingested ration. From these values, a preliminary NIRS predictive equation will be developed.

DISCUSSION

The technique is believed to be applicable to all herbivores, especially ungulate herbivores, and has potential to increase the present level of knowledge concerning a multitude of factors relating to large ungulate management. The availability of this technique presents a cheap and efficient method for: 1) determining the diet quality of free-ranging ungulates from seasonal forages; 2) determining inter-herbivore impacts on nutrient availability in multi-species grazing situations; 3) relating stocking rate to forage availability and quality; and 4) increasing levels of management possible for domestic and wild populations of grazing animals. For example, application of this technique to winter grazing livestock allows the livestock manager to quickly and efficiently keep informed of nutrients available to livestock and , in the event that nutrient levels decline below desirable levels, the manager can make the decision to provide protein and/or energy supplements to livestock.

Mineral Status of Steers in Eastern Oregon

H.A. Turner and P.D. Whanger

SUMMARY

Liver, hair, and plasma mineral levels were monitored in range steers throughout a complete year to determine the influence of seasons and management practice on mineral status. Samples were taken from steers at two locations (Burns and Union) in eastern Oregon, starting shortly after weaning and at four times during the year, which represented times of major feed changes. Half of the steers at each location were fed a commercial trace mineralized salt mix, with those at Union receiving additional Se, and the other half were fed iodized salt (control). Weight gains were 345 and 367 pounds for the control group and trace mineralized salt group, respectively, at Burns; and 495 and 528 pounds at Union. Based on plasma and/or liver levels, marginal to deficient conditions existed for Cu, Zn, Co, and Se at various times at one or both locations, which are generally representative of western range areas. The mineral mix prevented deficiency of Se, Co, and at times Zn, but was not effective for Cu. There was little correlation between mineral content of hair samples and levels in the liver. Data showed that sampling at a single time was not sufficient to establish long-term mineral status.

INTRODUCTION

Trace mineral supplements recommended for grazing cattle in eastern Oregon are generally based on the mineral composition of forages. Copper (Cu) deficiency in beef cattle from different areas in Oregon has been suggested from plasma and liver Cu levels and from Cu and molybdenum (Mo) levels in feeds. Western Oregon has been classified as deficient in selenium (Se) while eastern Oregon is considered "variable" regarding the Se level of forages. Marginal zinc (Zn) deficiencies are considered a possibility in Oregon with the western United States (including Oregon) as an area adequate in cobalt (Co).

A purpose of this investigation was to evaluate the influence of the typical ranch management practices on the Cu, Se, Zn, Co, Mo, and manganese (Mn) status of growing cattle. Another objective was to monitor mineral status and needs on a year-round basis using mineral content in liver biopsy samples, in both pigmented and white hair and blood plasma as indicators. Although this study was conducted in eastern Oregon, it is anticipated it would serve as a model to assist in the evaluation of mineral status in cattle on range areas in many parts of the world.

MATERIALS AND METHODS

This investigation was conducted at the Eastern Oregon Agricultural Research Center. At Union, with a higher elevation and greater precipitation during the summer, the grass becomes green earlier and stays green longer than at Burns. Burns has a typical "high desert" vegetation in summer. At both locations, cattle were fed harvested forages during winter and allowed to graze on rangeland at other times.

Twenty-two crossbred Hereford steers (4 months old at Burns, 383 pounds; and 5 months at Union, 519 pounds) were used at each site. At each location, one-half (control) received iodized salt as a supplement and the other half a commercial trace mineralized salt (TM) fed free-choice in ground form, in mineral boxes. The TM salt contained (mg/kg) sodium chloride, 970 to 990; Zn, 3.5; Mn, 1.8; Magnesium (Mg), 3.7; iron (Fe), 2.0; Cu, 3.5; Co, .06; and iodine (I), .10. At Union the steers also were given Se (25 mg/kg) as sodium selenite mixed with the TM salt, because prior work suggested low Se content in forages at this location. Bone meal was provided on a free choice basis to the groups. The trial lasted from weaning in the fall through the end of the following summer. During the winter the steers were pen-fed ad libitum in groups according to treatment. Steers at Union were fed ad libitum a second-cut, rain-damaged alfalfa hay and at Burns they were fed meadow hay. During the other seasons the groups at each location grazed separate meadows with the carrying capacities controlled so as to be comparable. At Union the steers grazed tall fescue (*Festuca arundinacca*) pasture during fall and were on forested range the following spring and summer. Although the forage endophyte level was not determined, there has not been any indication from previous work that this is a problem. The forested range consisted of grand fir forest (*Abies grandis*) on the north slopes, with adjoining mixed conifer forest, wet meadow, and riparian zones. Dominant plant species were grand fir, Douglas fir (*Pesudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), nine bark (*Physearpus malvaceus*), ocean spray (*Holodisus discolor*), snowberry (*Symphoricarpos albus*), pine grass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), and Kentucky bluegrass (*Poa pratensis*). At Burns, the steers grazed a meadow regrowth during the fall and pure stands of crested wheatgrass (*Agropyron desertorum*) during the spring and summer. The hay during the winter and forage in the fall included about 75 percent of the biomass as rushes (*Juncus* sp.) and sedges (*Carex* spp.). The principal species are rusty sedge (*Carex subjunca*) and baltic rush (*Juncus balticus*). The remaining 25 percent consisted of grass and shrub species. The most abundant grasses were Nevada bluegrass (*Poa nevadensis*), meadow barley (*Hordeum brachyanthorum*), meadow foxtail (*Alopecurus pratense*), and beardless wildrye (*Elymus triticoides*).

Steers were weighed and plasma, liver biopsy, and pigmented and non-pigmented hair samples were taken at weaning, at the end of the fall grazing period (November), at the end of winter (April), at the end of spring (July), and at the end of the summer grazing period (September). Newly grown hair was collected from the jaws and neck or from the forehead (white hair) and side just behind the right shoulder (colored hair) each time blood or liver samples were collected. This was done by clipping the hair with coarse clippers and subsequently with a fine-head clipper. Random samples of feed and forage were also collected for mineral analysis throughout the experimental period (Table 1). Forage samples during the grazing times were collected at times indicated in Table 1 by walking diagonally across each meadow and clipping them at ground level. Cored samples from at least 20 bales of hay were taken to be analyzed.

A Jarrell Ash atomic absorption spectrophotometer was used to measure Cu and Zn concentrations on diluted plasma samples and in the feed and livers after acid digestion. The

Table 1. The mineral composition of the forages consumed by the steers at Union and Burns (mg/kg DM).

	Union						Burns					
Season	Cu	Mo	Se	Zn	Co	Mn	Cu	Mo	Se	Zn	Co	Mn
Fall (B)	2.7	-	0.01	14.1	0.07	43	3.2	1.6	0.21	28.3	0.04	68
Winter (C)	9.5	9.6	0.03	18.2	0.28	-	3.5	2.3	0.22	26.7	0.08	53
Spring (D)	5.7	-	0.02	08.8	-	38	4.5	-	0.02	19.1	-	-
Summer (E)*	5.2	-	0.02	23.6	-	-	1.2	-	0.01	12.0	0.09	21
	2.6			23.4	0.10	61	1.1	6.9	0.02	11.8	0.17	31
	1.9	3.7	0.03	21.3	0.07	92	0.9	5.1	0.02	10.9	0.24	40
	1.5	4.6	0.2	27.0	0.14	64	1.2	5.3	0.01	10.3	0.18	32

*The four sampling dates during the summer were 6/10, 7/15, 8/14, and 9/17 at Union and 7/21, 8/20, 9/22, and 10/13 at Burns

Co levels in the feed and liver, Mo and Mn levels in feed, liver, and plasma, and Zn, Cu, Mo, Mn, and Co in hair digest were determined using a Perkin Elmer atomic absorption spectrophotometer. Selenium in the feed, tissues, and hair was determined by a fluorometric procedure. Mineral content of liver and hair is expressed on a dry-weight basis. A bovine liver reference standard (NBS) was used in all mineral analyses.

RESULTS AND DISCUSSION

Weight Gains

The average daily gains (ADG) of steers during each phase of the trial are presented in Table 2. Unexpectedly, the ADG was less in steers given TM at Burns during spring than in those not given TM. During the summer, however, both groups lost weight, presumably because of the nutrient content of the typical "high desert" vegetation in summer at Burns. However, those given TM lost less weight. During the winter the TM group at Union gained more weight than the group receiving iodized salt. ADG for the entire study for steers fed iodized salt and TM salt was, respectively, .88 and .95 pounds at Burns, and 1.36 and 1.45 pounds at Union. The average total weight gain per animal for the year for steers fed iodized salt and TM salt were, respectively, 345 and 367 pounds at Burns, and 495 and 528 pounds at Union (data not shown). This response to TM could be due to a single mineral or a combination of several. Young growing animals are most likely to show a response in live-weight gain to Cu supplementation while grazing a Cu-deficient pasture. Prior studies here suggested that Se could also account for some of this response.

Mineral Intake from Supplement and Composition of Feed.

Intake of TM mix (Tables 3 and 4) at Union was significantly higher than that at Burns. Since steers at Union were heavier than those at Burns, the relative differences

Table 2. Seasonal differences in average daily gains (lb/d) of steers at two Oregon locations.

	Union		Burns	
Seasons	Salt	TM[a]	Salt	TM[a]
Fall	.86	.99	.92	.95
Winter	.77	1.03	1.14	1.28
Spring	2.00	2.00	2.11	1.65
Summer	2.09	1.96	-.64	-.33
Overall	1.36	1.45	.88	.95

[a]Trace mineralized salt.

between mineral requirements and mineral intake from the supplement were greater there. Supplemental Cu intake was 15 to 30 percent of requirements at Union and about 50 percent of requirements at Burns. The TM supplement supplied 40 to 80 percent of the Se requirements at Union. About 50 percent of the Mn requirement was supplied through the TM mix at Burns, while below 50 percent of the Mn required was supplied at Union. Supplemental Co intake was in excess of requirements at both locations.

Copper content in the feeds (Table 1) decreased from fall to the next summer at Burns while Mo levels increased. At Union, the Cu and Mo levels in the winter feed were much higher than those during grazing. Over 100 percent of the Zn required was supplied by the TM supplement at Burns, and over 50 percent was supplied at Union. The Zn level of the feed from Burns was lower in the spring and summer grass than in the roughage fed to steers in fall and winter, but the opposite occurred at Union. Cobalt in feed at Burns increased from .04 mg/kg in fall and winter to > .09 mg/kg in spring and summer. The Se level in feed at Burns was higher during fall and winter than in the other seasons, and also higher than at Union.

A "good" free-choice mineral supplement is one that supplies at least 25 to 50 percent of the requirements for the mineral to the animal, or 100 percent in a region of known deficiency. Any response to the mineral supplementation should be evaluated in terms of the proportions of total needs supplied and the levels of these minerals in the available feed relative to the needs of the animal.

Minerals in Liver and Plasma

Copper. The Cu concentration in livers (Figure 1, top) of steers in Burns decreased from weaning in the fall to levels of between 10 to 20 μg/g liver during the other seasons, with slight recovery in summer. The same trend was observed in plasma Cu levels (Figure 1,

Table 3. Body weights of steers and estimated daily mineral requirements of the steers at Union and amounts supplied by the trace mineralized supplement during the different seasons of the trial.

			Copper		Selenium		Zinc		Cobalt		Manganese	
Season	Body weight end of season, lb	Estimated[a] feed intake, lb	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg
Fall	579	11.7	42	12.4	1.06	0.88	159	124	0.53	2.1	212	64
Winter	722	14.5	53	11.2	1.32	0.80	198	112	0.66	1.9	264	57
Spring	882	17.6	64	15.6	1.60	1.12	240	156	0.80	2.7	320	80
Summer	1042	20.9	76	11.2	1.90	0.80	285	112	0.95	2.6	380	68

[a]Estimated as 2% body weight
[b]Cu, 8 mg/kg; Se, 0.2 mg/kg; Zn, 30mg/kg; Co, .1 mg/kg; Mn, 40 mg/dg [NRC (23), Table 4].

Table 4. Body weights of steers and estimated daily dietary mineral requirements of the steers at Burns and amounts supplied by the trace mineralized supplement during the different seasons of the trial.

			Copper		Zinc		Cobalt		Manganese	
Season	Body weight end of season, lb	Estimated[a] feed intake, lb	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg	Required[b] in diet, mg	Supplied by mix, mg
Fall	427	8.6	31	19.6	117	196	0.39	3.4	156	101
Winter	678	13.0	47	19.6	177	196	0.59	3.4	236	101
Spring	779	15.6	57	29.1	213	291	0.71	5.0	284	149
Summer	750	15.0	54	29.1	204	291	0.68	5.0	272	149

[a]Estimated at 2% body weight, except for actual average intake of hay during winter.
[b]Cu, 8 mg/kg; Zn, 30 mg/kg; co, .1 mg/kg; Mn, 40 mg/kg [NRC (23), Table 4].

bottom), although the lowest level was reached in winter with a subsequent increase to levels of .7 mg/L at the end of summer. This was similar to that at weaning in the fall. TM supplementation did not have a consistent effect on plasma Cu levels, although in winter and spring they were higher in the group fed the TM supplement than in the controls. At Union, liver Cu levels increased in winter above levels (10 to 20 mg/kg) observed at weaning in the fall and further decreased in the spring. In summer, Cu levels increased to above 25 mg/kg. Plasma Cu dropped from a level of .65 mg/L to between .45 and .55 mg/L in winter and spring, and increased again to .7µg/ml in summer. There were no significant increases in plasma and liver Cu concentrations associated with the Cu supplementation, except in the plasma of steers at Burns at the end of spring.

The Cu requirements for beef cattle have been estimated to range from 4 to 10 mg/kg. However, the concentrations of ingredients such as Mo and S can have a major influence on the minimum level of Cu required in a ruminant feed. Based on calculation of available Cu in pastures, this resulted in a very low availability of cu in the feed at Union and Burns. Although forage levels of Cu are helpful to evaluate Cu status, hepatic and plasma levels are more useful. Hepatic Cu concentrations below 20 mg/kg or 25 mg/kg DM have been suggested as indicative of Cu deficiency in growing cattle, but other work revealed that grazing livestock with hepatic Cu levels ranging from 8 to 32 mg/kg showed no clinical signs of Cu deficiency. At Union, the liver Cu levels in animals given the TM salt mix were 25 mg/kg dry matter (DM) or below during all time periods except winter. The high level of Cu in livers of both groups in Union, during winter could be a "systemic effect" due to the Cu x Mo x S interaction of high Mo intakes, but plasma Cu levels would also have been expected to be high.

The plasma with liver Cu levels support the conclusion that 3.5µg Cu/g in the TM supplement used at Union and Burns was insufficient to completely overcome Cu deficiency in the steers. This agrees with conclusions of other studies under different environmental conditions. Unless higher levels are used in TM mixes, the use of Cu injections or slow-releasing Cu products in the rumen may be more effective in overcoming the Cu deficiency in steers.

Molybdenum. Liver Mo levels of steers at Burns (Figure 2) remained fairly constant throughout the trial. Plasma Mo levels of steers were not determined because of insufficient plasma sample size. At Union, plasma and hepatic Mo levels of steers were higher at the end of the winter feeding period than at any other time. The Mo concentrations in tissues of ruminants tend to correspond with daily Mo intakes, provided all other conditions remain constant. In our investigation, the Mo levels in the plasma and livers fluctuated between about 3 and 12 mg/kg in the livers and .16 and 1.60 mg/L plasma (Union), and appeared to be influenced by the Mo concentration in the feeds.

Selenium. At Burns, where no Se supplementation was done, Se levels in the liver and plasma (Figure 3) were higher at the end of fall and winter than at any other time. At Union, Se supplementation of steers resulted in a significant positive response in plasma and liver Se concentrations at all stages of the trial except at weaning. When no Se was fed to steers, the Se levels remained fairly constant at .2 mg/kg in the liver and .02 mg/L in plasma.

The NRC recommended a dietary concentration of .20 mg/kg as the minimum Se required by beef cattle while others propose a level of .1 mg Se/kg feed. Provision of Se supplement was consequently effective in significantly increasing plasma and liver Se levels, and the response in weight gain could be due to Se. The plasma and liver Se contents at Burns reflected the adequate content of forage Se during fall and winter. During spring and summer, however, the feed Se level was reduced to .02 mg/kg, accompanied by a drop in the plasma and liver Se levels in the steers.

Zinc. At Burns and Union, hepatic Zn concentrations decreased after weaning and remained fairly constant (Figure 4) at 80 to 90 mg/kg during the other seasons, with a slight increase in steers at Burns at the end of summer. The TM mix did not significantly influence the liver Zn concentration at either location. Plasma Zn levels decreased after weaning, reaching minimum levels at the end of fall at Burns and at the end of winter at Union, reflecting low forage levels, e.g., 10.3 mg/kg in summer at Burns (Table 1). At the end of winter and spring, the plasma Zn level was higher in the supplemented steers than in the control animals.

Research indicates 10 to 14 mg Zn/kg feed as sufficient to maintain serum Zn levels between .8 to 1.0 mg/L in animals; however, calves would require higher Zn levels in their feed, 18 to 43 mg/kg under most practical situations. A range of 20 to 40 mg Zn/kg feed has been recommended for beef cattle. Research has suggested the critical level for Zn in serum was between .6 and .8 µg/ml, which is consistent with Idaho studies where calves with .84 mg/L plasma gained 6 percent more weight when Zn was added to their diet. Thus, it would appear that a marginal Zn deficiency existed at both locations. Unfortunately, there are no effective biochemical measures for determining a borderline deficiency of Zn in livestock.

Cobalt. Except at weaning and at the end of summer, a significant response was obtained in Co concentration in the livers of steers (Figure 5) at Burns due to TM supplementation. At Union, Co levels in the liver stayed relatively constant throughout the experimental period with no difference between the salt mix and the TM supplement fed to steers.

A concentration of .1 mg Co/kg feed is considered adequate for beef cattle, with ranges from .05 to .07 mg Co/kg given as critical. The Co levels of the forages at Union fluctuated at near-adequate levels during the experimental period, yet the liver Co increased in steers given the TM salt treatment. The low Co level in the feed during fall and winter at Burns is potentially deficient and resulted in the winter hepatic Co concentration of .065 mg/kg in the TM salt-fed steers there. At both locations, the TM mix supplied amounts of Co well above that required by the steers (Tables 2 and 3). Liver Co levels are not considered a very sensitive measure of Co status, but vitamin B_{12} levels appear to be better indicators of such status in ruminants. Our results, combined with the feed analyses, indicated a possibility of marginal Co deficiency at Burns.

Minerals in Hair. Although Zn, Cu, Se, Mo, Mn, and Co were determined in hair, only the Cu, Zn, and Se levels are presented to indicate the difficulty involved in assessing mineral status by this method (Table 5). Cu levels were significantly higher in the white hair than the colored, but in contrast the Se levels were higher in the colored hair. There were no significant correlations between hair levels of Zn, Cu, Se, Mo, Mn, or Co with the content of these minerals in the liver or plasma, except for plasma Cu and liver and plasma Se.

The use of hair mineral content as an indicator of mineral status does not appear feasible, since the mineral levels (Zn, Mn, Fe, Na, Ca, Cu, and K) of hair are affected by season, breed, hair color within and between breeds, age, and body location. Although our study indicates a possible relationship between plasma Cu and hair Cu (Table 4, Figure 1), this is not supported by the work of others. Moreover, we found that the Cu content of white and colored hair was different, which is inconsistent with other observations. Our results and those of others indicate that hair Se levels might give a rough estimate of Se status, but the disadvantages of using hair, i.e., the need for thorough washing to remove foreign contamination and finding a reproducible location on the animal would appear to outweigh the advantages. Others agree that because of many factors that cause variation in mineral content of hair, hair analyses are not likely to be precise indicators of the mineral status of animals.

Table 5. Average mineral concentration of colored versus white hair from steers μ/g).

Hair Color	Union			Burns		
	Cu	Zn	Se	Cu	Zn	Se
Colored	5.1	129	0.34	5.1	142	0.53
White	6.5	148	0.24	6.3	153	0.34

CONCLUSIONS

This study was conducted in two locations in Oregon which are reasonably representative of the Great Basin and other range areas. Results indicate that accurate assessment of the mineral status of livestock requires that multiple samples must be taken throughout the year. The other obvious lesson is that the mineral content of the plasma does not always reflect that in the liver. For example, the plasma Cu levels at the end of the winter feeding period were lowest, but the hepatic levels were highest compared to other time periods in the cattle at Union (Figure 1). This could reflect a higher Mo concentration at this time in both plasma and liver than at any other time (Figure 2). This trend for Cu is the opposite of expected results from other work and further work is necessary to explore this apparent paradox. Furthermore, the trace mineral supplements used did not provide enough Cu to prevent deficiencies (Figure 1) and did not produce any consistent significant increase of Cu in liver or plasma. Neither does the Zn level in the TM mix appear to be high enough to result in adequate Zn status. Thus, the TM mix composition should be revised for areas similar to eastern Oregon.

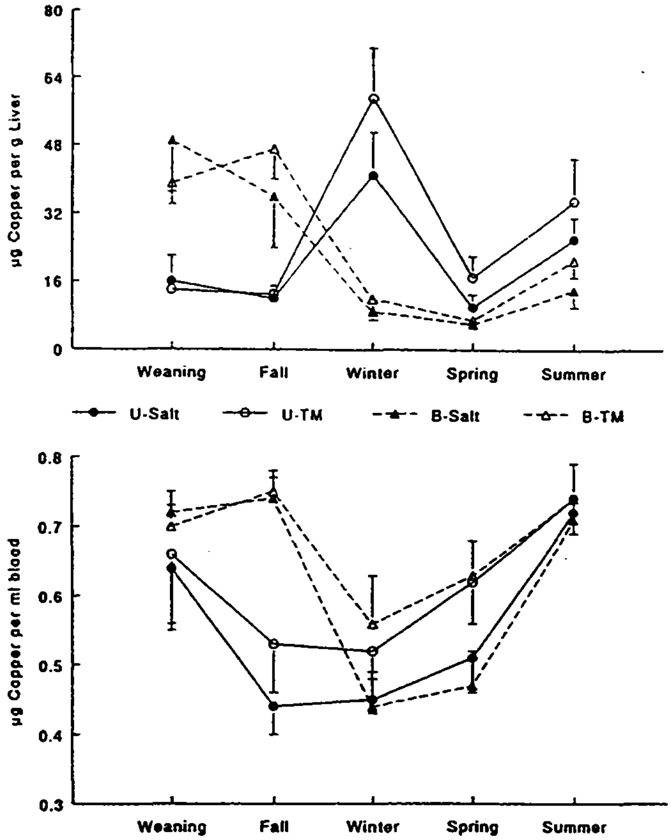

Figure 1. Liver and plasma copper levels in steers at Union (U) and Burns (B) at weaning and at the end of fall, winter, spring, and summer when receiving a salt or a trace mineralized (TM) supplement. Vertical bars represent standard deviations.

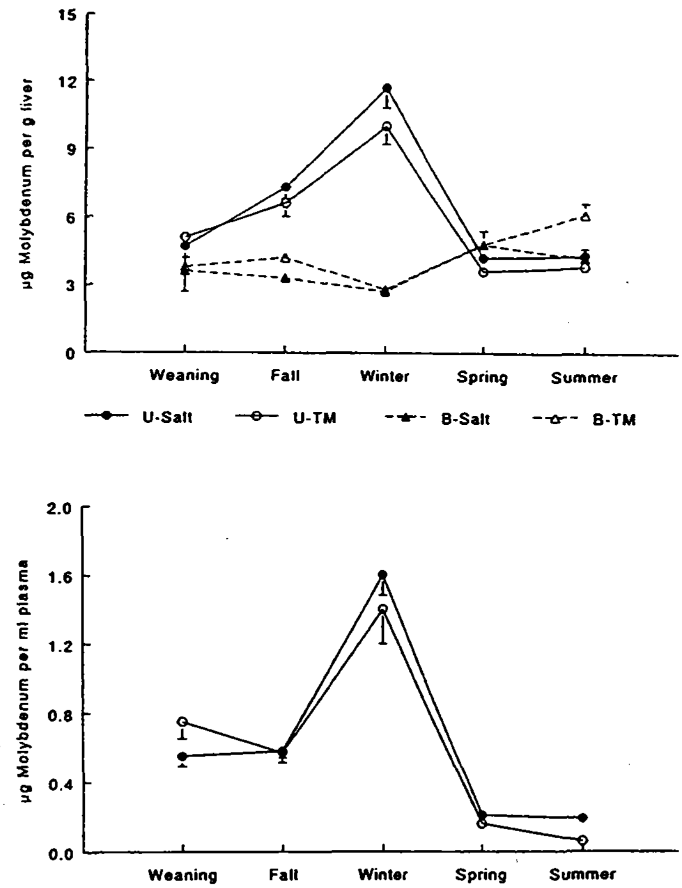

Figure 2. Liver molybdenum levels in steers at Union (U) and Burns (B) and plasma molybdenum levels in steers at Union at weaning and at the end of fall, winter, spring, and summer when receiving a salt or trace mineralized (TM) supplement. Vertical bars represent standard deviations.

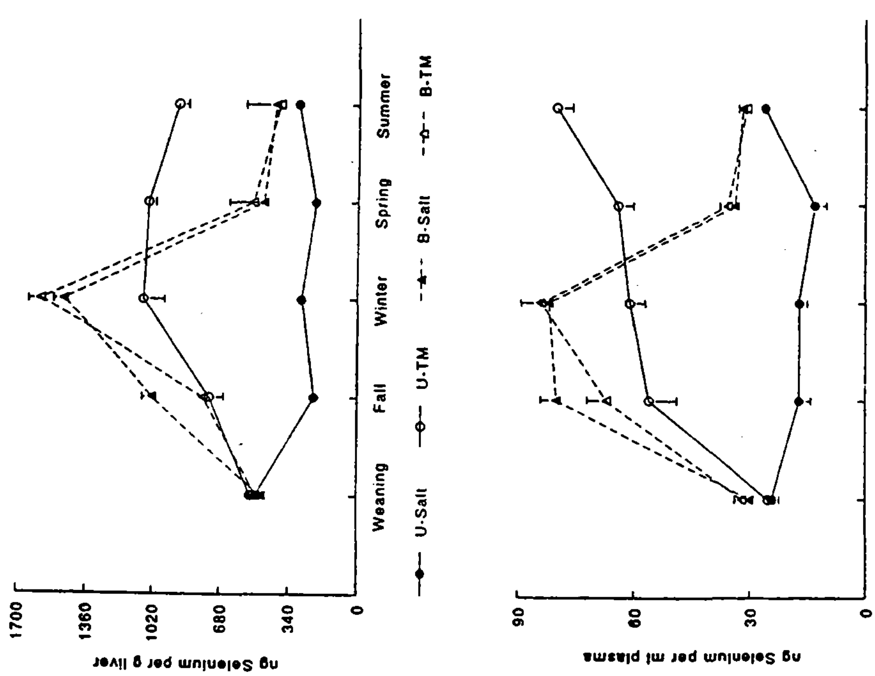

Figure 3. Liver and plasma selenium levels in steers at Union (U) and Burns (B) at weaning and at the end of fall, winter, spring, and summer when receiving a salt or a trace mineralized (TM) supplement. Vertical bars represent standard deviations.

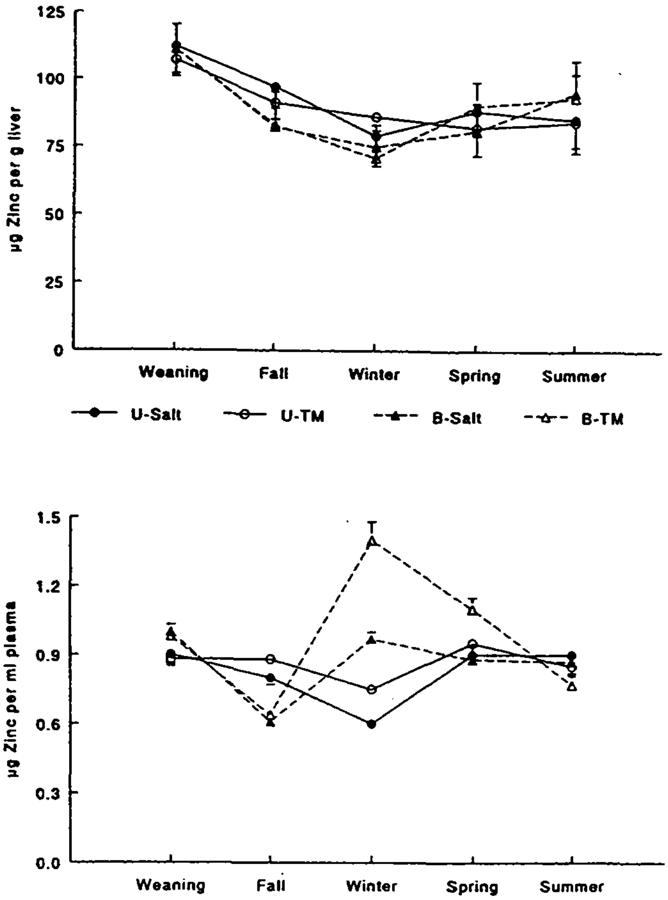

Figure 4. Liver and plasma zinc levels in steers at Union (U) and Burns (B) at weaning and at the end of fall, winter, spring, and summer when receiving a salt or trace mineralized (TM) supplement. Vertical bars represent standard deviations.

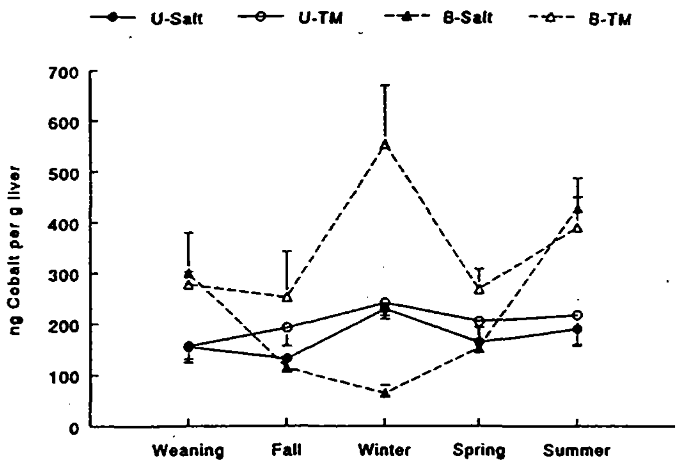

Figure 5. Liver cobalt levels in steers at Union (U) and Burns (B) at weaning and at the end of fall, winter, spring, and summer when receiving a salt or a trace mineralized (TM) supplement. Vertical bars represent standard deviations.

Energy Supplementation for Cattle Grazing Native Meadows

Ray Angell, Roxane Barton, and Tim DelCurto

Native flood meadows of Harney Basin are classified as seasonally wet because of the early spring snowmelt. Meadows are generally wet from April through June and control of flooding is minimal, which often prevents harvesting of forage at a point when quality is optimal. Grazing during May and June is an alternative management practice which is becoming more common. This strategy can provide excellent weight gains during late spring and early summer; however, performance is sometimes depressed when forage is immature. Actively growing immature forage often lacks the energy needed by animals to adequately digest the forage and produce positive weight gains. At other locations, small amounts of energy supplements have been shown to increase the efficiency of digestion and help put the animal in a positive energy balance. Thus, the objective of this study was to evaluate the effects of energy supplementation on intake, digestibility, digestive kinetics, and performance of heifers grazing native flood meadows.

MATERIALS AND METHODS

This study was conducted at the Eastern Oregon Agricultural Center (EOARC) located approximately 7 miles south of Burns, OR. The 55-acre pasture selected for the study was dominated by meadow foxtail, along with saltgrass, reed canarygrass, quackgrass, and Nevada bluegrass.

Two experiments were simultaneously conducted from May 3 until July 14, 1993. The first experiment, a performance trial, utilized 84 Hereford x Angus heifers (average beginning wt 598 pounds). Heifers were weighed, and randomly assigned to one of the following treatments (21 heifers/treatment): 1) Control (CON, grazing only); 2) Low (LOW, grazing plus 1.1 pounds cracked corn/head/day); 3) Medium (MED, grazing plus 1.65 pounds cracked corn/head/day); 4) High (HI, grazing plus 2.2 pounds cracked corn/head/day). Heifers were weighed every 14 days throughout the 72-day trial.

The second experiment utilized 10 ruminal cannulated Hereford x Angus steers (average beginning wt 609 pounds). Steers were weighed and randomly assigned to either CON or MED treatment groups (five steers/treatment). Steers were allowed to graze with the heifers, and were used to determine intake, diet digestibility, and digestive kinetics. Digestive kinetics were estimated using an external marker technique. Intake was then calculated from fecal output and diet digestibility.

RESULTS AND DISCUSSION

Nutrient composition of diets (Table 1) consumed by steers showed no differences ($P>.10$) between supplemented- and non-supplemented groups. Diet crude protein (CP) was 19.4 and 20.6 percent for supplemented and non supplemented steers respectively. In vitro organic matter digestibility (IVOMD) was not different between groups and averaged 73 percent.

Intake estimates were measured using IVOMD (digestibility of the diet) coupled with fecal output estimates (intake = fecal output/portion of diet not digestible), and expressed on an organic matter basis (adjusted for water and mineral content of forage). Organic matter intake was similar between groups (Table 2; P>.10), and averaged 12.6 pounds forage/day or 1.88 percent of body weight (BW) across treatments.

Although supplementation had no effect on forage intake estimates, digestive kinetics were influenced by supplementation. Particulate passage rate (%/hour) through the digestive tract was increased (Table 2; P<.05) from 2.7 percent for non-supplemented animals to 3.3 percent for animal receiving supplement. Rumen retention time (hours; total amount of time required for digestion or breakdown of forage as to allow passage from rumen to lower digestive tract) was decreased with supplementation (CON = 45.1, MED = 35.9; P<.05). Likewise, supplementation also decreased gastrointestinal mean retention time from 56.5 to 45.7 hours (P>.01). Gastrointestinal fill (pounds; total amount of organic matter "substance" in the digestive tract from rumen to rectum) was depressed with supplementation (P<.05). Supplemented animals had 4.23 pounds of fill compared to 5.26 pounds for non supplemented animals.

In vivo digestibility estimates are based on an in situ nylon bag that contains a preweighed sample of grazed forage. Nylon bags are then suspended in the rumen for various amounts of time. Extent of forage dry-matter disappearance, or the percent of forage digested from the nylon bag after 72 hours, was not effected by supplementation (Table 3; P>.10). Likewise, rate of forage dry-matter disappearance, or the percent-per-hour digested from the nylon bag, was not affected by supplementation (Table 3; P>.10; CON = 6.8, MED = 5.9).

Final heifer weights for the 72-day trial were similar across all treatments with a final average weight of 781 pounds (Table 4). Likewise, average daily gain (ADG) was also similar among treatments, and heifers gained approximately 2.2 pounds/day (Table 4).

CONCLUSION

Although some differences were noted in digestive kinetics; diet quality, rate of digestion, and intake estimates were all similar. Moreover, at the end of 72 days, no differences in weight or rate of gain were noted between supplemented and non-supplemented heifers. When the bottom line is pounds of gain and the cost of those pounds, under the conditions of this study it was not economically feasible to provide these animals with energy supplementation.

Table 1. Nutrient composition of diets consumed by steers grazing meadow forage during late spring, and receiving 0, or 1.65 pounds cracked corn.

	Treatment	
Item[a]	1.65	0
OM, %	83.7	82.8
NDF, %	55.7	55.5
ADF,%	31.1	30.3
CP, %	19.4	20.6
IVOMD, %	73.2	72.2

[a]OM = organic matter; NDF = neutral detergent fiber, ADF = acid detergent fiber, N = nitrogen, IVOMD = in vitro organic matter digestibility.

Table 2. Organic matter intake, and digestive kinetic variables for steers grazing high-quality meadow vegetation and supplemented with 0 or 1.65 pounds cracked corn.

	Treatment	
Item	.75	0
Forage OM Intake, lbs	12.3	12.9
Particulate passage rate, %/h[a]	3.3	2.7
Rumen retention time, h[a]	35.9	45.1
Gastrointestinal mean retention time, h[b]	45.7	56.5
Gastrointestinal fill, lbs[a]	4.23	5.26

[a]Row means differ (P<.05).
[b]Row means differ (P<.01).

Table 3. Dry-matter disappearance of forage consumed by steers grazing meadow forage and receiving 0, or 1.65 pounds cracked corn.

	Treatment	
Item	1.65	0
Forage DM Disappearance		
72 h, %	86.3	88.0
Rate, %/h	6.8	5.9

Table 4. Average final weight (pounds) and average daily gain (pounds per day) of heifers grazing meadow forage and receiving cracked corn supplement during a 72-day trial.

	Corn Supplement (lbs/d)			
Item	0	1.1	1.65	2.2
Avg. weight, lbs	774 ± 75	774 ± 66	790 ± 68	785 ± 64
Avg. daily gain, lbs	2.2 ± .2	2.2 ± .2	2.4 ± .2	2.4 ± .2

Effect of Selenium on Feed Efficiency of Steers Wintered on Selenium Deficient Hay

Calvin Nunn, Harley Turner, and Dan Drake

SUMMARY

The objective of this study was to test the effect of selenium (Se) on feed efficiency of steers. Steers receiving supplemental Se were found to consume 0.34 percent less forage on a dry-matter basis, based on body weight.

INTRODUCTION

Much of the feed produced on the Eastern Oregon Agricultural Research Center (EOARC), Union Station, is selenium (Se) deficient (<.05 ppm). Station cattle traditionally respond to supplemental Se in terms of additional weight gains or improved reproductive performance. Past studies have not measure feed efficiency. In year 1, 89 Hereford X Simmental weaned steers were utilized to test the effect of supplemental Se on weight gain and feed efficiency on a Se deficient diet.

MATERIALS AND METHODS

Steers were stratified by weaning weight and randomly assigned to treatments of Se or control. Se treated steers received controlled release selenium boluses releasing 3 mg per day (Dura Se-120 Shering -Plough Animal Corp. Kenilworth, New Jersey), on day 0 of the study. Steers ran together at Union with adequate shelter, free access water, and free access to selenium deficient hay (.023 ppm). Hay, in 1,100-pound round bales, was fed in 4-round bale feeders.

Steers were weighed three times over the 105-day study at days 0, 56, and 105. Animals were gathered the previous afternoon and shrunk overnight, without access to feed or water. Blood was collected from each animal on weigh dates, in 10-ml purple-topped EDTA Vacutainer tubes, for determination of Se content of whole blood. Whole blood Se determination was performed by fluorometry following nitric and perchloric acid digestion and dissolution of whole blood sample.

Intake and feed efficiency were determined on 20 head of steers with the use of chromium marker boluses (Captec Chrome Captec PTY. Ltd. Australia). Steers were paired based on their 56 day weight, 10 control, and 10 Se treated. Chromium boluses were administered on day 56. Steers receiving chromium boluses ran in a pen separate from the remaining steers until the end of fecal collection. Seven fecal samples were collected between days 8 and 18 after administering chromium boluses, and then composites were made to achieve a representative sample for each animal. Twelve core samples were taken on six round bales that were fed to steers with chromium boluses, to analyze in vitro digestibility.

RESULTS AND DISCUSSION

Steers receiving Se consumed less hay; however the difference was not statistically significant. Intake of steers receiving the Se boluses was 0.34 percent less on a dry-matter basis, based on body weight, than the controls. Weight gains over the length of the trial were similar between controls and Se-supplemented group, with both groups losing. Losses were 9.2 pounds for the controls and 9.5 pounds for the Se-supplemented groups. Weight loss was due to poor-quality forage with no concentrate supplements. Both protein and energy were deficient. Properly fed, this class of animal should gain between .75 and 1.5 pounds per day to realize an economic return on a winter feeding program. Actual target levels would depend on future management of these steers.

Adequate blood Se levels are .03 to .05 ppm. Whole blood Se values of .130 to .212 ppm for these animals did not indicate a deficiency for either group.

A few years ago, the effect of Se on gain and feed consumption was tested, in Alturas, California. These studies found similar gains in controls and Se-injected groups; however, there was a decreased hay consumption of 1.58 pounds one year and 0.61 pounds another, in the selenium-injected group. It is interesting to note that despite the poor feeding regime and adequacy of Se blood levels throughout the trial, our results were similar to those of the California studies in terms of feed efficiency.

CONCLUSIONS

Decreased intake with the same gain means less feed is required for each increment of gain. A .34 percent decrease in intake for a 500 pound steer equals 1.9 pounds of hay per day assuming 90 percent dry-matter. A feed savings of 1.9 pounds per steer for 100 steers comes to 190 pounds per day. Steers wintered over 150 days would equate to a total savings of just over 14 tons of hay. A repeat of this study is currently underway.

Effect of Vitamin E and Selenium Injections on Scours, Plasma Copper Concentration, and Immune Status of Newborn Beef Calves.

Calvin Nunn, Harley Turner, Phillip Whanger, and Robert Van Saun

SUMMARY

Objectives of this study were to study the effect of vitamin E and Se treatments on: 1) scours, 2) plasma immunoglobulin (Ig) concentration, and 3) plasma mineral concentrations. Within each treatment, calves that experienced scours had decreased plasma vitamin E when compared to healthy calves. Immunoglobulin mu (IgM) was not affected by scours or treatment. Immunoglobulin gamma (IgG) concentrations were decreased in calves with scours. Scours increased plasma copper (Cu) over time, when compared to unaffected calves.

INTRODUCTION

Scours, like the common cold, is not initiated by any one factor. Several microorganisms are responsible for scours. Several other factors promote the onset of scours, most notably weather, and may be beyond the control of ranchers who calve their cows on muddy wet feeding grounds. In Oregon it is estimated that scours cost cattlemen an average of 10 million dollars annually, and in peak scour years such as 1989 this figure can be five to six times higher. Thus, studies have been underway to investigate factors influencing the incidence and severity of scours.

Much research has been done with vitamin E and selenium (Se) and their effect on the immune system. The importance of Se and vitamin E in disease resistance has been shown in many studies. This research project is attempting to bolster the immune system of calves to alleviate scours. This is particularly important for beef producers whose cows calve within a short time frame, where calves are confined to small areas. Bolstering the immune system may reduce the incidence or duration of the illness thus reducing costly drugs administered to afflicted calves. This investigation conducted during the winter of 1993 is part of a continuing study on the effect of vitamin E and Se on scours. Previous work with the experimental herd at Eastern Oregon Agriculture Research Center (EOARC) has shown plasma vitamin E to be decreased ($P<.01$) and copper (Cu) elevated ($P<.05$) in calves with scours. Objectives of this study were to determine the effect of vitamin E, Se, or the combination treatment on scours incidence and plasma concentration of vitamin E, Se, Cu, IgG, and IgM in newborn beef calves.

Results of this study will hopefully lead to recommendations for cattle producers that will alleviate some problems with calf hood maladies during the calving season. This would be particularly beneficial to those animals calving in the severe climates of eastern Oregon.

MATERIALS AND METHODS

The facilities of EOARC at Union were used for this study, with cows from both

Union and Burns stations. Hereford x Simmental cattle were utilized from Union and consisted of 49 first-calf heifers and 160 cows. One-hundred-sixty Hereford x Angus cows from Burns were also utilized. Thirty days prior to expected calving of the first animal within the calving group, cattle were assigned to one of four treatments, in a 2x2 factorial arrangement, using a randomized block design with calving date used as the blocking factor. Treatments consisted of a controlled release Se bolus that provided 3 mg per day, and an intramuscular injection of 10,000 IU of α-tocopherol (**+vit +Se**), vitamin E injection alone (**+vit**), Se bolus alone (**+Se**), and no vitamin E or Se supplementation (**control**). Treatments for calves consisted of intramuscular injections of Se based on birth weight (0.027 mg/lb) at birth and 2 weeks of age and vitamin E at birth (1500 IU), 2 and 4 weeks of age (750 IU). Calves were on the treatment regimen corresponding to their dams.

Calves were bled at birth and at weekly intervals for 4 weeks. Blood was collected into 10 ml Na-EDTA tubes, and centrifuged to obtain plasma. Plasma was frozen at -20 °C until analyzed. Plasma vitamin E was extracted in heptane and concentrated in methanol and concentrations were determined by liquid chromatography. Cu plasma levels were determined via Perkin-Elmer Atomic Absorption/Flame Emission Spectrometer (Perkin-Elmer Corp. Norwalk, CT.). Healthy calves were pooled for plasma Se analysis. Plasma Se determined with a Perkin-Elmer 3030 instrument (Perkin-Elmer Corp., Norwalk, CT) equipped with an electrode-less discharge lamp and automatic Zeeman-effect background correction. IgG and IgM determinations were performed using a commercial radial immunodiffusion kit (VMRD, Inc., Pullman, WA). Incidence of scours was scaled from 0 (no scours) to 4 (severe dehydration and requiring I.V. electrolytes).

Statistical analysis was performed using Statistical Analysis Systems (SAS ver. 6.08). The GLM procedure was used in all analysis with repeated measures used in analysis over time (age of calf). Analysis was performed as a completely randomized design, as the effect of the blocking factor (calving date) was inefficient. The three factors considered were vitamin E, Se, and scours.

RESULTS AND DISCUSSION

Plasma vitamin E concentrations of calves was increased ($P<.001$) by intramuscular injections of vitamin E. Treatment of calves with vitamin E decreased ($P<.003$) plasma Se levels across all treatments. Plasma Se was increased ($P=.001$) by treatment with intramuscular injections of Se. These data indicate that injections of vitamin E and Se were effective in raising plasma levels of vitamin E and Se. Calves affected with scours had lower ($P<.05$) plasma vitamin E than unaffected calves within the same treatment, consistent with previous research on this herd. Scours incidence, maximum value, and duration were not responsive to treatment; however incidence and severity of scours was minimal.

Cu concentrations in the plasma was not affected by treatment of calves with either vitamin E, Se, or the combination of the two; however, plasma Cu increased ($P<.001$) with age. Scours, over the sample dates, increased ($P<.005$) plasma Cu concentrations when compared to unaffected calves. Cu concentration is known to increase with viral and bacterial challenges in cattle; therefore plasma Cu is expected to increase in calves with scours.

Total plasma IgG concentrations decreased ($P=.0001$) from birth to the fourth week of age. This decrease in total IgG is representative of the loss of passively acquired colostral antibodies with time, before the immune system of the calf is fully functional. Calves affected with scours had decreased (P<.02) IgG concentrations, compared to unaffected calves, across all treatments. IgG concentrations tended to be affected (P<.06) by Se with a scours interaction, when averaged over all time points. Se directly affected total IgG concentration dependent upon age of calf (P<.01) and vitamin E treatment (P<.01). Scours did not decrease total plasma IgG concentration in Se treated groups, while IgG concentration decreased with scours in control and vitamin E treatment groups. IgM concentrations were low with high variability; therefore, total plasma IgM was not found to be affected by scours or either of the vitamin E and Se treatments.

Calving interval was decreased in first-calf heifer's with vitamin E injections. Calves from the heifers injected with Se were heavier at weaning than those not injected. The mature cow herds did not exhibit any differences on calving interval, weaning weight, or average daily gain due to treatments.

This data suggests that the immune system is enhanced with Se and vitamin E injections. Differences in morbidity and mortality were not seen; however, differences were observed with the more sensitive measures of the immune system. Difference in morbidity may be observable with increased incidence and severity of scours.

CONCLUSIONS

Calves that experience scours have lower vitamin E plasma levels, but more research is needed to determine if decreases in plasma vitamin E are a cause or an effect of the scours. Vitamin E injections decreased the calving interval for first-calf heifers, which allows an earlier breed back after calving and increased weaning weights of their calves. Immune system tests have shown vitamin E and Se to enhance the immune system. Morbidity and mortality differences may need more severe weather conditions or a higher level of challenge from disease organisms before differences are apparent. Further work is being conducted on the relationship between scours and vitamin E. Vitamin E is now being fed on a daily basis as opposed to the injections in this trial.

The Influence of Physical Modification and Supplementation Strategies of Grass Seed Straw on Beef Cattle Intake, Feed Efficiency, and Performance

Tim DelCurto, Teena Tibbs, and Roxane Barton

INTRODUCTION

Beef cattle producers in the pacific northwest are faced with numerous challenges that threaten their economic survival. Public land grazing has declined, and may continue to do so, forcing beef cattle producers to rely more intensively on private lands. In addition, winter feed demands of 1.5 to 2.5 tons of harvested forage place many producers at a competitive disadvantage relative to beef cattle producers in the midwest and southeast portions of the United States. Use of crop residues, such as grass straw, may provide alternatives to traditional winter feeds and free up private lands to assist producers with declining access to public land grazing.

The Eastern Oregon Agricultural Research Center has provided a wide range of research on supplementation, chemical modification, nutritional quality, and antiquality factors of grass seed residues fed to beef cattle during the winter period. Recent research has focused on evaluating chopping and pelleting of grass seed straw as a means to improve the intake and use of grass seed residues by beef cattle. The objectives of the following studies were 1) evaluate the value of chopping and pelleting of grass seed straw (Experiment 1), and 2) evaluate the influence of alfalfa supplementation frequency on the intake and use of pelleted grass straw (Experiment 2).

Experimental Design

Two experiments were conducted to evaluate the value of pelleted straw feed products and alfalfa supplementation strategies on the intake, feed efficiency, and performance of weaned heifers during the winter feeding period.

Experiment 1 (Union Station). Seventy-eight head of Simmental X Hereford weaned heifers were stratified by body condition and weight, and randomly allotted within stratum to two replications of the following three treatments:

1. Long Stem Tall Fescue Straw + Pelleted Alfalfa
2. Pelleted Tall Fescue Straw + Pelleted Alfalfa
3. Pelleted Tall Fescue Straw/Alfalfa Mixture

All diets were identical in composition with daily rations consisting of 75 percent tall fescue straw and 25 percent alfalfa. On a daily basis, all treatment groups were offered a diet consisting of 9.5 percent crude protein (CP) and . 95 Mcal metabolizable energy (ME). Treatment differences related to the physical form of the straw (treatment 1 versus 2) and strategy of providing supplemental alfalfa (treatment 2 versus 3). All pens of heifers were fed once daily, whereas feed refusals were evaluated once weekly to evaluate pen intake and feed efficiencies. The study was initiated in early January and feeding of treatment rations continued for an 84-day period.

Experiment 2 (Burns Station). Eight-four head of weaned Hereford x Angus heifers were stratified by body condition and weight, and randomly allotted within stratum to three replications of the following four treatments:

1. Pelleted Tall Fescue Straw + Pelleted Alfalfa every other day
2. Pelleted Tall Fescue Straw + Pelleted Alfalfa daily
3. Pelleted Tall Fescue Straw + Pelleted Alfalfa twice daily
4. Pelleted Tall Fescue Straw/Alfalfa Mixtures

All diets were composed of 75 percent Tall Fescue Straw and 25 percent alfalfa. Treatment differences related to the frequency of alfalfa supplementation versus mixing alfalfa directly into the pelleted straw diet. Nutrient compositions and feeding procedures were identical to the Union Station study.

Table 1. Weight and Body Condition Changes of Weaned Heifers Consuming Differing Forms of Fescue Straw During a Winter Feeding Period (Union Station).

Period	Straw hay + alfalfa	Straw pellets + alfalfa	Straw:alfalfa pellets	SE[a]
Initial				
weight, lbs[b]	530.9	541.9	548.7	8.20
body condition[b]	4.44	4.57	4.43	.09
0-42 days				
wt change, lbs[b]	12.2	51.6	47.7	3.01
condition change[b]	.21	.0	.0	.15
42-84 days				
wt change, lbs[b]	2.4	17.4	19.8	3.84
condition change[b]	-.38	.04	.0	.13
0-84 days				
wt change, lbs[b]	14.6	69.1	67.5	2.99
condition change[b]	-.59	.04	.0	.13
Total Feed Intake, lbs[b]	11.87	15.30	15.72	---
Straw Intake, lbs[b]	8.89	11.60	11.79	---
Feed:Gain Ratio,				
lbs feed/lb gain[b]	68.3	18.60	19.56	---
84-126 days				
wt change, lbs	23.8	26.2	28.0	8.29
condition change	.47	.11	.23	.12

a Standard Error of the means (N=2).

b Pelleted straw treatment diets differ from long-stem straw treatment diets ($P<.01$).

RESULTS AND DISCUSSION

Experiment 1. Heifers that received pelleted straw rations made greater gains and maintained body condition better than heifers consuming long-stem straw hay (Table 1; P<.01). Daily gains of the heifers consuming pelleted straw rations were .81 pounds per head per day, whereas heifers consuming straw hay gained only .17 pounds per head per day. Straw and total feed intake was increased by 30 percent in heifers receiving pelleted straw diets compared to straw hay diets. Likewise, feed:gain ratios were improved three-fold in heifers consuming pelleted straw diets relative to heifers consuming long-stem straw hay diets.

Experiment 2. Weight gain and body condition changes tended to improve over the 84-day feeding period with increasing frequency of alfalfa supplementation (Table 2; P=.12). Differences in weight and body condition across treatments were biologically similar, with gains of approximately 1.39 pounds per head per day. No benefit was realized when the alfalfa hay was mixed directly into the straw diets compared to pelleted straw diets where the alfalfa was hand-fed separately. Feed efficiency was similar across treatments (P>.10). with all treatment groups needing 11.2 to 12.3 pounds of feed to produce 1 pound of gain.

Table 2. Weight and Body Condition Changes of Weaned Heifers Consuming Pelleted Grass Products with Differing Frequencies of Alfalfa Supplementation (Burns Station).

Period	Frequency of Alfalfa Supplementation .5X Alfalfa	1X Alfalfa	2X Alfalfa	Straw/ Alfalfa Mix	SE[a]
Initial					
weight, lbs	435.2	432.0	440.9	431.9	3.34
body condition	4.07	4.00	3.90	4.12	.08
0-42 days					
wt change, lbs	66.7	68.2	69.7	69.4	3.89
condition change	.38	.40	.50	.29	.12
42-84 days					
wt change, lbs	45.6	55.6	50.7	41.2	2.91
condition change	-.05	.06	.07	-.13	.17
0-84 days					
wt change, lbs[b]	112.3	123.8	120.6	110.6	3.67
condition change[b]	.33	.46	.57	.15	.11
Total Intake, lbs/hd	15.05	16.49	16.28	16.22	------
Straw Intake, lbs/hd	11.45	12.31	12.16	12.16	------
Feed:Gain Ratio					
lbs feed/lb gain	11.26	11.19	11.34	12.32	------

[a] Standard Error of the means (N=3).

[b] Treatment means tended to differ with increasing frequency of alfalfa supplementation (P=.12).

DISCUSSION

Averaged across location, heifers on the pelleted straw rations gained greater than 1 pound/head/day. Using the National Research Council (NRC, 1984) recommendations, a 500 pound yearling heifer gaining 1 pound/day should receive a diet with at least the following minimum characteristics:

DM Intake	11.8 lbs
Crude Protein	9.4% or 1.1 lbs
Metabolizable Energy	1.02 Mcal/lb or 2.25 Mcal/kg
TDN	62%

The rate of gain reported for growing heifers in these studies is very impressive. For instance, early-bloom alfalfa hay would not have the nutrient composition to support the above NRC recommendations.

Conversions (feed:gain ratios) are 33 percent better in the Burns Station study relative to the Union Station study. This difference can be attributed to a number of factors. Specifically, the Union herd is composed of higher-producing (heavier milking) Hereford x Simmental cattle that may require higher nutrient demands relative to the Hereford x Angus cattle which compose the Burns research herd. In addition, previous nutritional management of the heifers, prior to the start of these studies, may have had an impact on efficiency of feed conversion across locations.

Previous research has shown that supplementing grass seed straw (without physical modification) will only support the nutritional requirements of mature cattle that are nonlacting during the winter feeding period. In contrast, this research indicates that pelleting long-stem straw dramatically improves its utility in growing rations of weaned heifers during the winter feeding period. This type of nutritional approach would provide adequate gains with growing animals during the winter feeding period. The final decision to utilize pelleted grass seed straw products for winter nutrition programs will depend on the cost of these pelleted straw products relative to traditional feed resources which could promote a similar level of weight gain response.

The Influence of Supplemental Alfalfa Quality on the Intake and Utilization of Low Quality Roughage by Beef Cattle with Varying Levels of Protein Requirements

Tim DelCurto, Christoph Weder, Tony Svejcar, Roxane Barton, and Alison Early

INTRODUCTION

Beef cattle production in the Pacific Northwest is dependent on feeding harvested forages during the winter feeding period. The cool Mediterranean climate and associated effects on forage resources and winter conditions necessitate feeding of 1.5 to 2.5 tons of forage per cow during each winter period. Relative to other areas of the United States, as well as world industry, this is a competitive disadvantage and often corresponds to smaller profit margins in times of less than desirable beef cattle prices.

The economic survival of beef cattle production in regions where high winter feed costs are common may be dependent on the ability of producers to optimize the use of low-quality roughage with minimal supplemental inputs and the maintenance of an acceptable level of beef cattle production. Evaluation of alternative winter forages and efficient/economical supplementation strategies may be a key in assisting producers to meet this challenge.

In the Pacific Northwest, alfalfa hay is the favored supplement for lower-quality hays and straws. Relative to by-product supplements (cottonseed and soybean meal), alfalfa hay is more readily available, and in most cases, is economically favorable even when evaluated on a crude protein (CP) equivalent. In most cases, however, beef cattle producers are content to purchase alfalfa hay that is unsuitable for "dairy-quality" markets or export markets. Frequently, the quality of alfalfa hay used in beef cattle feeding is of late maturity or has been exposed to excessive precipitation.

The objective of this research proposal is to evaluate three maturities of alfalfa hay and to determine how maturity, in turn, influences the value of alfalfa as a supplement to low-quality roughage. These alfalfa supplements will be evaluated in terms of beef cattle performance, reproductive efficiency, and detailed digestion efficiency.

Experimental Design

Alfalfa Hay Maturities. The second cutting of alfalfa hay from a 60-acre field will be utilized for obtaining the three maturities of alfalfa hay. The 60-acre field will be divided into four blocks, and within the four blocks the three maturities will be randomly obtained by evaluating the phenology of the plant to harvest at: 1) a late vegetative stage, 2) a early bloom stage, and 3) a mid-to-late bloom stage. The treatment maturities of alfalfa will be baled into small rectangular bales (100 pounds) and randomly mixed across blocks within maturity treatment groups.

Cow performance Studies. Two beef cattle performance studies will be conducted to evaluate the three maturities of alfalfa hay. In experiment 1, 90 head of mature Hereford x Angus cows will be utilized in a winter feeding study using a basal diet of moderate-to low-quality meadow hay. The 90 head of cows will be divided into nine groups (10 head each) and fed one of the following supplemental treatments: 1) vegetative alfalfa hay (high quality), 2) early bloom alfalfa hay (moderate quality, and 3) mid-to-late bloom alfalfa hay (low quality). Treatment 1 will be fed at .5 percent body weight (BW), with treatments 2 and 3 adjusted to provide an equal amount of protein. In experiment 2, 84 head of weaned heifers will be utilized in winter feeding study to evaluate the same treatments as described above. However, in experiment 2, supplementation of treatment 1 will be set at .75 percent BW, and treatments 2 and 3 will be adjusted to reflect the same amounts of supplemental protein as treatment 1.

The two beef cattle performance studies will yield two distinctive groups of beef cattle with differing protein requirements and a potential to show divergent responses to supplemental alfalfa qualities. As a result, this research will yield data that will be applicable to both growing and mature beef cattle feeding strategies with low-quality roughage.

Both studies will be started in November or early December and treatment supplements will be fed for an 84-day period. Body condition and weights will be determined at days 0, 28, 56, and 84 following an overnight shrink. Subsequent body weight and condition measures will be obtained just prior to breeding and after the summer grazing period. Reproductive success will be evaluated by conception rates and calving interval evaluation.

Digestion Studies. Eight ruminally cannulated steers will be utilized in a dual 4X4 Latin square design to evaluate the following treatments: 1) control, basal diet, no supplement; 2) basal diet plus vegetative alfalfa hay; 3) basal diet plus early bloom alfalfa hay; and 4) basal diet plus mid-to-late bloom alfalfa hay. Like the performance studies, alfalfa supplements levels will be adjusted, so that equal quantities of crude protein are provided to the low-quality basal diets on a daily basis.

Square 1 will be comprised of yearling steers, whereas square 2 will be comprised of 4-year-old steers. These two sets of steers will effectively allow us to evaluate the influence of animal protein needs versus supplemental alfalfa qualities on the intake and utilization of low-quality roughage. Each steer (within a square) will be utilized across four study periods where they will be exposed to all four treatments. Each digestion period will consist of a 14-day adaptation period, 6-day intake period, and 6-day fecal collection period, respectively. On day 27, a ruminal profile will be conducted, followed by ruminal evacuation to determine digesta kinetics on day 28. Data from the digestion studies will include the following:

- dry-matter intake and digestibility
- In Situ rate and extent of digestion
- ruminal pH and VFA concentrations
- NDF digestibility
- liquid and particulate passage rates
- ruminal NH_3

Expected Results

Results from this research program will help clearly describe the value of alfalfa quality when used as a supplement for low-quality roughage. This, in turn, will aid beef cattle producers in designing winter feeding strategies which provide an optimal level of beef cattle nutrition and economic margins for successful production systems. This project is currently underway with completion expected by July, 1996.

Applying Grazing Management Strategies to Mitigate Elk Impacts on Agricultural Land

Dennis P. Sheehy and Ron Slater

SUMMARY

Elk and deer use of agricultural land in the north Grande Ronde Valley has been monitored since 1993. In 1994 fertilization, salting, water development, and forage seedings, treatments were applied to seasonal rangeland on the perimeter of the valley floor. Additional treatments will be applied in 1995. Elk and deer use will be monitored through 1997 to determine if forage enhancement will change elk use of agricultural land.

INTRODUCTION

The perimeter of the Grande Ronde Valley in northeastern Oregon is a mosaic of forested land, seasonal rangeland, and agricultural land that provides favorable habitat for wintering Rocky Mountain Elk (*Cervus elaphus nelsonii*). Elk use of privately owned land, particularly agricultural land during the cropping season from late spring to early fall, has created the situation whereby landowners regard the presence of elk in the area as being incompatible with agriculture. Increasing the complexity of the issue is the urbanization of former timber/rangeland areas into small landholdings. Landowners express a diversity of opinions concerning elk use of the valley floor.

A major factor influencing the conflict over elk use of agricultural land is the incomplete habitat for elk on the valley floor that influences elk to use agricultural land as a habitat substitute. Conversion of land to agriculture, logging of forest lands, grazing by domestic livestock, and urbanization has altered elk habitat and elk behavior. The total area of traditional elk winter habitat has been reduced, or significantly altered, while creating habitat attractive to elk during other seasons.

The primary goal of the study is to develop grazing management strategies that minimize the impact of elk on agricultural land on the valley floor. A secondary goal of the project is to foster cooperation among landowners, wildlife management agencies, and private supporters of elk. Support for the project, in addition to Eastern Oregon Agricultural Research Center and the Oregon Department of Fish and Wildlife, has been provided by private and public organizations, including the Rocky Mountain Elk Foundation and the USDA-Forest Service.

MATERIALS AND METHODS

The project that was initiated in January, 1993, is being implemented over a 5-year period. Pre-treatment monitoring of elk use of the valley floor occurred between 1993 and 1995. Grazing management treatments were applied in the fall of 1994. Other applications are scheduled for spring and fall of 1995. Elk use of the valley floor will be monitored from

1995 to 1997 to determine treatment effect on elk behavior. Monitoring of elk use was accomplished by establishing vehicle observation routes around the perimeter of the valley. The routes are traveled three times a week.

Grazing management treatments implemented in the fall of 1994 included: 1) fertilization of 600 acres of public and private seasonal rangeland along the edge of the valley floor, 2) placement of salt licks at strategic locations on uplands surrounding the valley floor, and 3) the development of elk foraging areas away from the agricultural land. Treatments anticipated for the spring and fall of 1995 include: 1) establishment of five water sources on the largest and most secluded forested land area adjoining the valley floor, 2) establishment of salt licks, 3) additional fertilization of upland seasonal rangeland on the western and eastern perimeters of the valley floor, and 4) creation of additional elk foraging areas away from agricultural land.

RESULTS AND DISCUSSION

Since inception of the elk monitoring routes throughout the north Grand Ronde Valley, 1,600 observations of elk and deer use of valley floor land have been obtained. These observations constitute pre-treatment monitoring of elk and deer use of mostly agricultural land. Monitoring in 1995 will constitute monitoring of elk and deer use during the treatment phase of the project. Monitoring of elk and deer use in 1996 and 1997 will constitute post-treatment monitoring of elk and deer use. Treatment success will be determined by comparing pre- and post-treatment elk and deer use of agricultural land and the treatment area. Two years of post treatment monitoring will not only provide information on relative success of the treatments in mitigating elk and deer use of agricultural land, but will also provide information on the longevity of the treatment impact.

Pre-treatment observations of elk and deer use are currently being entered into a geographic information system (GIS). Observations of elk and deer also provide information on land type used, weather conditions, and timing of use, all of which can be spatially defined. Post-treatment observations and treatment areas will be entered as the information is obtained. Spatial analysis capabilities of the GIS will be used to determine if treatments caused significant changes in elk use of agricultural land, and to formulate guidelines for applying future treatments to mitigate conflict over elk use of the valley floor.

I'm New Here, What's Good to Eat?: Naive Cattle and New Forages

David Ganskopp and Ruben Cruz

SUMMARY

Naive animals (those not familiar with new circumstances) frequently have a difficult time coping in new environments. Forage selection and grazing behavior of naive and experienced steers were compared in experimental pastures on the Northern Great Basin Experimental Range near Burns, Oregon, in 1994. Experienced steers immediately began the trials grazing preferred forages (crested wheatgrass and basin wild rye) while naive steers sampled a greater variety of forages the first day. Throughout the 4-day trial, naive steers selected forage from the preferred grasses 69 percent of the time and the experienced steers 90 percent of time. Naive steers were more likely to take a single bite of a plant even though they spent more time at each feeding station than experienced steers. Experienced steers selected the closest plant about 51 percent of the time, and naive steers grazed the closest plant only about 32 percent of the time. As a result, naive steers traveled about 42 percent further than their experienced counterparts. These findings suggest that naive cattle may be at a nutritional disadvantage when they first enter a new environment, and it is suggested they be supplemented with some familiar forages when being shifted to new areas to compensate for their lack of nutritional experience. Animal gains may be less than expected due to greater energy expenditure for travel, especially if they are in rough terrain.

INTRODUCTION

Any animal that is moved to a new environment is typically at a disadvantage, and at first can not make efficient use of the resources on hand. Transplanting, particularly of our smaller wildlife species, frequently results in the deaths of many of the new arrivals. Larger animals, because they have more stored fats or body reserves, have a better chance of surviving transplants than their smaller cousins because they range over a larger area and have more time to learn where food, water, or cover might be located. Among livestock, naive animals are also more likely to eat poisonous plants than animals that are familiar with their forages. This is especially true of animals that are hungry after an extended trip. In general, we also find that transplanted livestock do not grow or gain weight as rapidly as animals that are experienced with the same pastures. While this has been widely noted, there have been few investigations that addressed exactly why newcomers do not fare as well as experienced animals. With these observations in mind, we designed an experiment to compare forage selection, grazing behavior, and nutrient intake by naive and experienced cattle. Our specific questions were: 1) Do naive and experienced cattle select the same forages? 2) If selection is different, do their diets become more similar as time passes? 3) Do naive cattle expend more or less effort in their foraging activities?

METHODS

Six yearling steers were used in the project. In their first year they grazed as calves on tall fescue pastures at the Union Experiment Station. At 6 months, all were transported to the Eastern Oregon Agricultural Research Center, Burns, where they wintered on flood meadow pastures and native hay. All were tamed so they could be easily captured and observed without undue disturbance to their behavior. One week before our trials, three of the steers were trucked to the Northern Great Basin Experimental Range and released to forage at will on native sagebrush/bunchgrass range. These animals are subsequently referred to as "experienced" animals while the steers remaining on the flood meadows are classified as "naive."

Seven days later the naive steers were trucked to the Experimental Range and maintained overnight on meadow hay. All steers were gathered the next morning and each animal was released into an experimental pasture supporting 800 forage plants. The 800 plants included 8 different types of grasses with 100 plants of each species available. Plants had been established in previous years, and were approximately 3 feet apart. Before our trials, samples of each grass were gathered for later analysis of forage quality and production. Forages included: bluebunch wheatgrass, Idaho fescue, squirreltail, needle and thread grass, Sandberg's bluegrass, Thurber's needlegrass, crested wheatgrass, and basin wild rye.

As each animal was released, we followed with a portable computer to keep track of the number of bites taken from each plant and the amount of time that elapsed between the first and last bite at each feeding station. We were also able to record how far each steer traveled as it foraged. Each animal was followed as it grazed on a total of 100 plants, which typically took about 40 minutes per steer. Trials were conducted over a 4-day period, and steers were kept in corrals and fed meadow hay each night.

RESULTS

Previous work at the Station has shown that crested wheatgrass and basin wild rye were preferred forages of cattle when grasses were green and growing. Our experienced steers entered their pastures and immediately began grazing on these two forages. Over the first day of grazing, roughly 90 percent of their visits were to these two species (Figure 1). The naive steers, however, began their first day with some exploratory grazing among the grasses. By the time they had foraged on 25 plants, roughly 60 percent of their diet was taken from crested wheatgrass and basin wild rye. By the end of the first grazing session or day, this increased to roughly 73 percent. Over all 4 days the experienced steers averaged 90 percent of their visits to the preferred forages, while the naive animals averaged only 69 percent. Both the naive and experienced steers appeared to go through a brief period (five to ten plants) of sampling the forages each morning as they began foraging (Figure 1). Quickly, however, they appeared to settle into selecting the preferred grasses at a relatively uniform rate.

Other aspects of the naive steer's grazing behavior suggested that they were not foraging as efficiently as their experienced counterparts. On average, an experienced steer harvested a total of 960 bites from crested wheatgrass and basin wild rye, while the naive animals averaged 690 total bites each day. Naive steers were also more likely to take single bites from plants than experienced animals. Thirty-seven percent of the time the naive steers removed only one bite from a plant before searching for another, while the experienced animals exhibited this behavior only 20 percent of the time. Also, the naive steers averaged about 8 seconds at each plant while the experienced cattle averaged only 5.5 seconds. This suggested that the naive steers spent more time handling forages than the experienced steers. The experienced steers harvested about 46 bites per minute, while the naive animals averaged 39. These two values are close enough, however, that we can not really say there was a significant difference between treatments.

The distances traveled by the steers also implied that the naive animals were less efficient foragers. Naive steers traveled about 318 yards during each grazing session while the experienced steers ranged over only 223 yards. Typically, the experienced steers traveled about 1.8 yards between feeding stations and the naive animals about 2.5 yards. All of these findings suggest that naive cattle are indeed less efficient foragers than experienced cattle. The naive animals make fewer visits to, and take fewer bites from, preferred forages. Conversely, they take more bites from the less, preferred forages than the experienced cattle. Overall, naive animals spent more time at each feeding station, but harvested fewer bites. They were less likely to seek out the closest plant to graze, and traveled further as they grazed. Our forage analyses are not yet completed, so we can not address the nutritional status of our treatments at this printing. We speculate, however, that the diet quality of naive steers was slightly lower than that of experienced animals.

Finally, we were not able to address the question of how long it takes for a naive animal to become an experienced individual. By the end of the fourth day the preferred forages in our experimental pastures were becoming depleted, so the selective opportunity of the cattle was diminished. This being the case, their diets would be forced to converge as time passed, so the trials were terminated. While a period of seven to fourteen days is frequently heard in discussions, no definitive research has addressed this question. In some instances, livestock shift readily to a new food or forage, and at other times palatable and nutritious rations may not be recognized as food for up to 30 days.

If livestock are transported to new environments or rations are to be shifted dramatically, a "soft transfer" is suggested. This could be accomplished by gradually introducing the novel foods to the animal in a familiar environment or furnishing familiar forages to the animal for a brief adjustment period in the novel environment. In either case the nutritional shock that occurs in the transfer would be moderated to some degree. If possible, calves destined to become replacement heifers should gain experience on the same types of ranges they will use as adults.

Figure 1. The percent of visits to preferred forages (crested wheatgrass and basin wild rye) by naive (------) and experienced (—) steers grazing among eight forages in pastures on the Northern Great Basin Experimental Range in 1994 over a four day period.