By Mort Kothmann

Exciting Changes in SRM Publications

Welcome to the **new** *Rangelands*. You will notice some changes in this issue of *Rangelands.* Gary Frasier, Editor-In-Chief, the *Rangelands* Steering Committee (David Bradford, Chair), and Alliance Communication Group (ACG) have worked together to reshape this important membership service publication. You will find new departments, special features, and special themes, all in full color. I hope you appreciate and are proud of this new look and content of *Rangelands.* This represents the combined efforts of many of your fellow SRM members over the past 2 years. We expect the new *Rangelands* to not only be a great service to our members, but to be a significant outreach tool to further the mission of SRM in the education of students and the public on the importance and management of rangelands.

Have you seen the January 2005 issue of the *Journal of Range Management*, now *Rangeland Ecology & Management*? It not only has a new name, it has a whole new look from the front color cover to the back. Keith Owens and the Associate Editors have been working with ACG for the past year to strengthen this publication and make it an even more effective science publication. This effort has been guided by the *Journal of Range Management* Steering Committee (Dave Engle, Chair) for the past 2 years. We welcome your comments on the changes that have been made in *Rangelands* and *Rangeland Ecology & Management*.

We hope you were at the 58th Annual Meeting of SRM in Fort Worth, Texas, in February 2005. This meeting is shaping up to be another record-breaking meeting following the tremendous meeting in Salt Lake City, Utah, last January. The SRM Annual Meetings are exciting and informative. There will be over 400 technical papers presented that represent the full biodiversity of the rangelands we love and manage. We expect nearly 2,000 professionals with extensive opportunities for networking. Federal agencies will have representatives on-site to interview for positions, and with authority to "hire-on-site." The entertainment will be outstanding and the venue is excellent. If you haven't made it to one of these events recently, start making your plans to be in Vancouver, British Columbia, next February 2006 for the 59th AM of SRM.

The members of SRM are working on many programs and activities. The new journals and the Annual Meeting are just a sample of the excellent work that is ongoing in SRM. It is a privilege to be a part of an organization where members care about the resource, support the mission of SRM, and care for each other. Keep up the great work and together let's make the next 60 years of SRM even better than the first 60 years.

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By Gary Frasier

Frasier's Philosophy

With this issue of *Rangelands* we are embarking upon a new journey. This journey is taking us to a new level of reporting items of interest in many aspects of rangeland resource management. Although this issue has a theme of "Forages and Grasslands," it includes items on several different topics. We hope that everyone will find something of interest.

You will notice that our layout has changed. This is part of our ongoing goal to make *Rangelands* more appealing to non-Society for Range Management (SRM) members. I will bet that if you leave a copy laying out on a coffee table or other visible spot in your house, you will find that at some point your guests will pick it up and start thumbing through it. You will also notice that *Rangelands* is now in full color. Wow! I can remember back when we were debating if we should have color front covers.

Several new items are included in this issue. One is a reprint of a recipe from the SRM *Trail Boss's Cowboy Cookbook*. We hope to generate a new interest in some of the old "family" recipes. If you have a recipe that you would like to share, please pass it along to me or a member of the *Rangelands* Editorial Board. We will publish selected recipes in future issues.

We will continue to include new features and items. Upcoming will be a column called "Ask the Expert." Do you have a question concerning rangelands, rangeland resources, or rangeland management? Send your questions to me. We will select 1 or 2 questions each issue and find an expert on the topic(s) to provide explanations you can understand. Remember, if you don't know the answer, you are probably not alone. There are other readers wanting to know the answer. I always say there is no "dumb" question. If I ask a question and you can give me an answer, then I have learned something. If you cannot provide an answer then we are of equal intelligence. While we work on about a 2–3 month publishing schedule, we will make every attempt to include items on a timely basis.

On another topic, I have been concerned for a number of years about placing our knowledge only in electronic media. I am afraid that, as our technology continues to advance, we may lose our ability to retrieve the information that was stored only a few years previously. How many readers can still access 5¼-inch floppy disks or data on magnetic tape or punch cards? Will our published technical research results meet the same fate? Hard copy information (paper) does not have to be adapted to fit the current technology. We must not forget that older books or journals contain valuable information. I have encountered several instances recently where some information was published, and I know that the author looked only at the information that was available through the Internet. It is good that we are going to have our research results (*Rangeland Ecology & Management*) included in the electronic media, but also remember that as technology changes these files MUST be updated, especially when they are stored in various academic facilities.

Many older researchers have files of old reprints of articles that are no longer in print. I am afraid that there will be instances where, when the researcher retires, the files will be lost

forever. To you older researchers (I am included in this category), consider placing them in a permanent repository somewhere. To you new researchers, not all information is on the Internet. Take time to go through files. Talk to older researchers; their memories may lead you to new ideas. You older researchers, before you are gone completely, find a younger individual to work with for a period of time. Many can greatly benefit from your knowledge. Be a mentor. We all know that failures are not usually published and yet we frequently learn more from our failures than we learn from our successes. I tell graduate students, "I will tell you of all my failures so you will not have to repeat them. The few successes I have had were usually based on ideas that did not work the first time. Don't re-invent the wheel." ◆

Forage Kochia–Uzbekistan's Desert Alfalfa

Forage kochia germplasm from Uzbekistan may increase fall and winter grazing and habitat for livestock and wildlife on western rangelands.

By B. L. Waldron, R. D. Harrison, A. Rabbimov, T. C. Mukimov, S. Y. Yusupov, and G. Tursvnova

Introduction

Forage kochia is often referred to as the "alfalfa of the desert" by Uzbek sheepherders and is one of their preferred rangeland forages. In the United States, the use of forage kochia for fall and winter livestock grazing is on the increase in the semiarid intermountain area. Past use of this perennial semishrub was mainly by public land agencies for rangeland restoration projects, including soil erosion control, greenstripping, and fire prevention, and to suppress invasive annual weeds, such as cheatgrass and halogeton. In fact, some scientists and range managers feel that forage kochia is the best plant to combat cheatgrass invasion and suppress wildfires on western rangelands.[1] Forage kochia has also been used for wildlife habitat and could be a "lifesaver" in maintaining mule deer herds as wildfire, large sagebrush die-offs, noxious weed invasion, and urbanization continue to reduce habitat and winter ranges.

The most recent interest, however, stems largely from ranchers and farmers who want to improve the forage quantity and quality on private depleted rangelands that are traditionally used for wintering livestock (Fig. 1). Recent research by the USDA, Utah State University, and the University of Wyoming have verified that forage kochia for fall/winter grazing has potential to improve the sustainability of the ranching industry in the West.[2,3] In response to the recent interest and requests from ranchers and rangeland resource managers, the USDA, Agriculture Research Service (USDA-ARS), initiated a forage kochia research program that included an evaluation of its adaptation and germplasm collection trips to Kazakhstan and Uzbekistan (Fig. 2).

Figure 1. Cattle winter grazing on forage kochia at the Salt Wells Cattle Company, Box Elder County, Utah.

USDA Forage Kochia Breeding Program

In 1998, the USDA-ARS Forage and Range Research Laboratory (FRRL) in Logan, Utah, initiated the forage kochia breeding and genetics program to develop taller, more productive forage kochia types. This was in response to desire for larger-statured types that provided improved live-

Figure 2. The Caucasus and central Asia region. Circles in Uzbekistan and Kazakhstan show the general areas of forage kochia collection and exchange.

stock and wildlife winter grazing and better game bird and small-mammal habitat.

As part of the research project, they completed a 3-year study that investigated the adaptability and the potential invasiveness of forage kochia. They found that forage kochia was widely adapted to the semidesert and desert ecosystems of the western rangelands and was not an aggressive invader in closed perennial plant communities.[4] It has been reported to encroach into alkali slick spots and dry lake beds where some sensitive species may exist.[4]

In view of the little variation in the stature and height of "Immigrant," a relatively low-growing forage kochia and the only released cultivar in the United States, FRRL scientists organized a forage kochia germplasm collection trip in 1999 to the Aral Sea region of Kazakhstan. This trip was made by USDA scientists in cooperation with the N. I. Vavilov Institute of Plant Industry (St Petersburg, Russia), the

Figure 3. United States Department of Agriculture and Uzbek scientists collect seed from a "Sahro" forage kochia plant that stands nearly 5 feet tall. Insert shows Sahro evaluation field in northern Utah.

National Academic Center for Agricultural Research of the Ministry of Science and Higher Education of the Republic of Kazakhstan, and the USDA-ARS International Programs and resulted in over 200 forage kochia collections (Forage Kochia Germplasm Collection Expedition to Russia and Kazakhstan—Plant Germplasm Collection Report, available at http://www.usu.edu/forage/kazakhstan.htm). These collections have been evaluated in the United States, and a representative core subset has been transferred to the USDA National Plant Germplasm System for maintenance and future use.

Further review of literature and communications indicated that scientists in Uzbekistan had developed and used several different forage kochia varieties during the Soviet era. Scientists from the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts visiting the Forage and Range Research Lab in Logan, Utah, described forage kochia types that stood nearly 5 feet tall and yielded 1,400 pounds per acre on less than 12 inches of precipitation per year (Fig. 3). Subsequent contacts were made with the Uzbek Research Institute, and a germplasm exchange was arranged to take place in Uzbekistan.

Uzbekistan's Forage Kochia Program

The germplasm collections and exchange took place in October 2002 at areas near Samarkand, Uzbekistan. The purpose of the expedition included the following: 1) to exchange seed of the US cultivar Immigrant forage kochia for Uzbek varieties of forage kochia representing subspecies *villosissima, canescens,* and *virescens*; 2) to arrange for cooperative studies comparing the performance of Immigrant and the Uzbek forage kochia varieties; and 3) to expand and develop contacts for germplasm exchange and related agricultural research with scientists and administrators associated with the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts at Samarkand, Uzbekistan.

Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts

Uzbekistan is a landlocked central Asian country the size of California and is bordered by Afghanistan, Kazakhstan, Tajikistan, and Turkmenistan. Uzbekistan leads the world in Karakul sheep production in both quality and quantity. Karakul sheep are well adapted to Uzbekistan's rangelands and are raised primarily for exportation of high-quality pelts used in clothing. They also account for 20% of the nation's total meat production and are valuable for wool and milk. All told, Karakul sheep are a primary source of income for over 2 million people living in the country's desert rangelands.[5]

Uzbek scientists have tried to reclaim the production potential and reverse the desertification process caused by centuries of intensive grazing of the country's vast desert and semidesert rangeland. One of their research emphases has been the development and testing of key plant species for use in range rehabilitation programs.[6] The Uzbek Research

Uzbek Research Stations

Karnab Experiment Station

The Karnab station is used to investigate and develop plant materials for rangeland restoration programs. It is located near the town of Karnab in the territory of the agricultural enterprise "Razzok Jahangirov," Nurabad providence, Samarkand region, and 93 miles northwest of Samarkand (lat 39'40"N, long 65'47"E). The station represents the sagebrush-ephemeral desert rangelands of the foothills of Uzbekistan. The elevation is 1,600 feet, and the site is characterized by an average annual air temperature of 58.3°F and annual precipitation of 6.5 inches. The majority of the precipitation is received during November to May. The soil surface texture is a silty clay loam and is classified as gray brown loamy with an occasional gypsum horizon.[6] Rangeland species evaluated at the station included forage kochia, haloxylon, four-winged saltbush, camphorosma, salsola, calligonum, and halothamnus. The current dominant native species in the nearby ecosystem included diffuse sagebrush, camel thorn, and bulbous blue grass (Table 2). Other plants found locally included cheatgrass, sedge, foxtail barley, spring grass, and locoweed.

Nurata Experiment Station

The Nurata experiment station is located near the city of Nurata in the Navoi region about 186 miles northwest of Samarkand (lat 40'28"N, long 65'42"E). The station represents the semidesert foothill rangelands of Uzbekistan. The elevation is 2,132 feet with an average annual air temperature of 59.7°F and annual precipitation of 9 inches. The majority of the precipitation occurs during November to May. The soil is classified as a sierozem and ranges from a fine sandy loam to a sandy textured surface.[6] Native species in the ecosystem, which consisted mainly of diffuse sagebrush and bulbous bluegrass, were similar to those found around the Karnab experiment station. Species in the research plots, which were established in 1986, were similar to those at Karnab.

Institute of Karakul Sheep Breeding and Ecology of Deserts was established in Samarkand in 1930 to support the Karakul sheep industry and provide information about improved forages. The institute has 15 scientific departments that focus on 3 main research efforts: 1) selection, breeding, and reproduction of Karakul sheep; 2) production and processing of Karakul pelts; and 3) evaluation and development of improved forages. The institute currently maintains close association with the International Center for Agricultural Research in Dry Areas (ICARDA) in Aleppo, Syria. Collaborative research with ICARDA includes replicated, on-farm evaluations of sheep performance and reproduction as associated with different rangeland conditions (Fig. 4). Forage kochia has been extensively evaluated at the institute and has proven to be one of the most successful plant materials for improvement of semiarid rangelands.

Figure 4. The institute conducts cooperative research with the International Center for Agricultural Research in the Dry Areas on the correlation between sheep performance and rangeland condition. Here an institute scientist and technician examine a ewe in the study.

Forage Kochia Germplasm of Uzbekistan

During the germplasm expedition, Uzbek scientists shared information about forage kochia use, classification, ecology, biology, and genetics. Forage kochia, the Uzbek "alfalfa of the desert," is a highly preferred forage for sheep, goats, and cattle on Uzbek semiarid rangelands. From discussions and the translated reports, it was discovered that the institute classifies forage kochia into 3 types or subspecies: 1) sandy ecotype—spp. *villosissima,* originating from Kazakhstan and characterized as being more gray and pubescent and the least preferred by livestock; 2) stony ecotype—spp. *canescens,* originating from Kirghizia and characterized as being highly variable; and 3) clay ecotype—spp. *virescens,* originating from Uzbekistan and characterized as being the most glabrous and preferred by livestock. However, some scientists in Uzbekistan and the United States have adopted Balyan's classification, in which he combined spp. *villosissima* and *canescens* into the spp. *Grisea*.[7]

Figure 5. United States Department of Agriculture and Uzbek scientists collect wild forage kochia seed that has been protected from grazing by camel thorn. A herd of Karakul sheep grazes in the background.

Table 1. Forage kochia (*Kochia prostrata*) varieties obtained in exchange between the USDA and the Uzbek Research Institute

Variety (subspecies)	Description
Otavny (*canescens*)	Otavny was developed using mass selection in stony ecotypes collected from foothill regions of Kirgizia. It is characterized as having both upright and semi-upright forms growing to a height of 2.5–3.0 feet and is especially noted for its regrowth ability after harvest. It is commonly grazed or harvested in June and allowed to regrow and grazed again during the fall and winter. Forage yields of 1,500 pounds per acre, and crude protein levels of 12%–16% have been reported. It is adapted to semisaline soils on sagebrush-ephemeral sites receiving 6–8 inches annual precipitation. Seed of Otavny was collected from 2-y-old spaced plants in a research nursery at the Karnab Experiment Station. It is later maturing at this site, and only a small amount of viable seed was obtained.
Karnabchulsky (*canescens*)	Karnabchulsky is described as a pasture-type forage kochia that is very palatable and grazing tolerant. It is known to be long-lived (12–15 y) and very drought tolerant with a deep-penetrating root (19–26 feet). Forage yields of 1,107–1,348 pounds per acre and protein levels of 13%–15% have been reported. It is adapted to sagebrush-ephemeral desert regions that have a mean annual precipitation of 4–8 inches. Karnabchulsky is reported to be mainly tetraploid (4x = 36) with some hexaploid off-types (6x = 54). We could not determine its origin. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station.
Sahro (*villosissima*)	Sahro is also described as a grazing-tolerant, palatable pasture type. It was developed using mass selection within a Kizilkum population of sandy ecotype. Shoots and leaves are very pubescent, and it is known for its prolonged vegetative period and semi-upright stature reaching heights of 2.1–2.5 feet. Yields of 1,340–1,518 pounds per acre (13%–15% protein) have been reported. It is adapted to sagebrush-ephemeral rangelands but is also suitable for sandy deserts receiving 3–5 inches of annual precipitation. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station.
Pustinny (*virescens*)	Pustinny was developed using repeated mass selection. It is mostly diploid with a large number of tetraploid off-types. Of all the Uzbekistan kochia, Pustinny is the most like Immigrant, with the exception that it is mostly yellowed stemmed versus red stemmed. While it is leafy, the leaves are smaller and more glaborous than the other Uzbekistan kochia. It is reported to be disease and pest resistant and to produce typical yields of 1,045–1,268 pounds per acre, with protein levels of 11%–13%. The institute reports suggest that it is adapted to desert and semidesert areas receiving 6–14 inches of annual precipitation. Seed was collected from a seed increase field established in 1986 at the Nurata experiment station prior to our arrival, suggesting that it may not be as late maturing as Immigrant.
Malguzarsky (*virescens*)	We believe this is the Malguzarsky-88 reported in some literature and that it was an original type used in Uzbekistan before 1972. Most likely, Otavny, Sahro, Karnabchulsky, and Pustinny were all developed as improved types, probably using 1 or more cycles of mass selection, as replacements for Malguzarsky. Malguzarsky is a diploid (2x = 18), and we believe that Pustinny may have been developed from selections within Malguzarsky. Seed was collected prior to our arrival from an old foothill planting in the Malguzarski region.
Wildland (*virescens*)	A wildland germplasm collection was made at a semidesert foothill area along the main highway between Samarkand and Tashkent, near Shzud-Amigdalis in the Jizzah region (Dzhizak city, lat 40'07"N, long 66'08"E). The soil surface texture is silt loam and is a typical serozem. The area receives an estimated 20 inches of annual precipitation per year. The average annual temperature is 57.2°F, and the elevation was about 2,788 feet. The rangeland was overgrazed, and the few unprotected forage kochia plants were heavily utilized. The plant community was comprised mainly of sagebrush species, bulbous bluegrass, and camel thorn. Tall wheatgrass was also found in a protected area. Seed was obtained from plants protected from grazing. This collection was predominantly yellow stemmed but also contained red-stemmed plants.

Note: The National Plant Germplasm System classifies *Kochia prostrata* as *Bassia prostrata*. However, this classification has not been recognized in Uzbekistan. Variety descriptions taken from unpublished report by Dr A. Rabbimov titled "Ecological and Biological Peculiarities and Achievements in the Selection of *Kochia prostrata* (L.) Schrad in Uzbekistan."

From the expedition, 6 Uzbek forage kochia germplasms/varieties were obtained. They included Otavny grown at the Karnab Experiment Station; Sahro, Karnabchulsky, and Pustinny from the Nurata Experiment Station; Malguzarsky from the mountains in the Malguzarski region; and a wildland collection from the Jizzah region between Samarkand and Tashkent (Fig. 5). A description of each variety is found in Table 1.

The Karnab station was established to investigate and develop the most suitable and desirable plant materials for rangeland restoration programs. It is located near the town of Karnab, about 93 miles northwest of Samarkand, and represents the sagebrush and short-lived grass desert rangelands of the foothills of Uzbekistan. The Nurata experiment station is located near the city of Nurata, where Alexander the Great had a major fortress. It is in the Navoi region, about 186 miles northwest of Samarkand, and represents the semi-desert foothill rangelands of Uzbekistan. The dominant native species in the area surrounding both stations included diffuse sagebrush, camel thorn, and bulbous blue grass (Fig. 6; Table 2).

From our observations, grazing of livestock, mainly Karakul sheep, was uncontrolled and unsystematic. The majority of the rangeland was in a low state of health. In heavily grazed areas near villages (Fig. 7), many of the desirable species had been replaced by the poisonous plant peganum and other undesirable species. Near Karnab, we observed haloxylon strips planted as windbreaks and a large forage kochia planting. Both had been seriously abused from firewood cutting and unrestricted grazing. Near this area, the sky was silhouetted with miles of concrete fence posts that had their wire illegally removed from them. Their presence indicated that an extensive grazing management system had once been implemented but now is gone.

Figure 6. Most rangeland that we observed was predominantly diffuse sagebrush (plant being eaten by donkey) with an understory of bulbous bluegrass and moderate amounts of camel thorn (green plant in background).

Figure 7. Uzbekistan's rural culture showing traditional clothing, cooking, and adobe structures.

Summary

Uzbek scientists have tested and developed excellent plant materials that are well suited for range reclamation programs. However, Uzbekistan's uncontrolled and unsystematic grazing makes it difficult to successfully use the plant materials to stop desertification processes. The Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts could make a significant contribution by documenting the relationships between rangeland condition and livestock performance. This type of information could assist Uzbek resource managers in implementing sound rangeland management policies and help them attain the full potential of their plant materials.

The USDA and Uzbek scientists were able to exchange seed of US and Uzbekistan forage kochia varieties. Scientists at the Uzbek Research Institute of Karakul Sheep Breeding and Ecology of Deserts and the USDA-ARS FRRL are comparing the forage kochia germplasms in both the United States and Uzbekistan. This coordinated program will have a lasting benefit for both the United States and Uzbekistan.

The Uzbekistan germplasm has been included with the Kazakhstan germplasm in the USDA forage kochia breeding program. Initial research is encouraging that breeding and selection, within these germplasms, will result in more productive, larger-statured forage kochia cultivars adapted to the

Table 2. Species frequently observed on Uzbekistan's rangeland

Common name	Scientific name
Bulbous bluegrass	*Poa bulbosa*
Camel thorn	*Alhagi pseudalhagi*
Calligonum	*Calligonum microcarpum*
Cheatgrass	*Bromus tectorum*
Diffuse sagebrush	*Artemisia diffusa*
Forage kochia	*Kochia prostrata*
Four-winged saltbush	*Atriplex canescens*
Foxtail barley	*Hordeum murinum spp. leporium*
Halogeton	*Halogeton glomeratus*
Halothamnus	*Halothamnus sp.*
Haloxylon	*Haloxylon aphyllum*
Locoweed	*Astragalus alocepias*
Peganum	*Peganum hazmala*
Salsola	*Salsola orientalis*
Winterfat	*Krascheninnikovia ewersmanniana*
Sedge	*Carex pachystachya*
Spring grass	*Eremopyrum orientale*
Tall wheatgrass	*Thinopyrum ponticum*

Note: The USDA National Plant Germplasm System classifies *K. prostrata* as *Bassia prostrata*. However, this classification has not been recognized in Uzbekistan.

western United States. These future cultivars have a real potential to improve the sustainability of western ranching by further reducing winter feeding costs. They should also be of great value to native ungulates and birds by providing valuable nutritional forage and cover and assisting in suppressing wildfires that are devastating their critical browse communities.

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Annual Wheatgrass: A New Look at an Old Invasive Range Weed

By James A. Young and Charlie D. Clements

Exotic, Invasive Range Weeds

If you wanted to write a book about exotic, invasive, annual rangeland weeds, the sagebrush/bunchgrass and salt desert ranges of the intermountain area of the western United States is the place to come. Red stem filaree, Russian thistle, barbwire Russian thistle, annual kochia, tumble mustard, shield cress, prickly lettuce, bur buttercup, cheatgrass, and medusahead are just a few of the many annual species that have invaded rangelands of the intermountain area during the 19th and 20th centuries. Halogeton and bur buttercup are poisonous, while red stem filaree and cheatgrass are significant forage species. Cheatgrass and medusahead have markedly changed the chance of ignition and rate of spread of wildfires. The lowering of the interval between wildfires has been devastating to the native woody species of intermountain rangelands. All these exotic species have claimed their share of soil moisture, the scarcest of all environmental factors for plant growth on these semiarid to arid rangelands. In this environment, competition for soil moisture by alien annual species closes many plant communities to the establishment of seedlings of native perennial species, ensuring continued dominance of the alien species. This has been shown by numerous studies reaching back over 75 years of research.

How Do We Acquire New Exotic Weeds?

There is no reason to believe that this onslaught of exotic species is not going to continue through chance introduction and escapes from ornamental or environmental plantings. It is somewhat but not completely surprising that an alien species that has been present on western ranges for much of the 20th century has suddenly been recognized as a species that is rapidly increasing its range and the variety of environments it infests. The species is annual wheatgrass.

Annual Wheatgrass

In the 1935 edition of A. S. Hitchcock's *Manual of Grasses of the United States,* this grass was listed under the scientific name of *Agropyron triticeum* Gaetn. Hitchcock did not offer a common name and indicated the species was sparingly introduced in the Absaroka Forest of Montana and near Mountain Home, Idaho. The origin of the annual wheatgrass was given as southern Russia. When Agnes Chase revised the *Manual of Grasses of the United States* in 1950,

Common and scientific names of plants mentioned in this article.

Common name	Scientific name
Annual kochia	*Kochia scoparia*
Annual wheatgrass	*Eremopyron triticeum*
Bailey greasewood	*Sarcobatus baileyi*
Black greasewood	*Sarcobatus vermiculatus*
Barbwire Russian thistle	*Salsola paulsenii*
Bur buttercup	*Ranunculus testiculetus*
Cheatgrass	*Bromus tectorum*
Crested wheatgrass	*Agropyron desertorum*
Needle grass	*Stipa*
Prickly lettuce	*Lactuca serriola*
Red stem filaree	*Erodium cicutarium*
Russian thistle	*Salsola targus*
Shadscale	*Atriplex confertifolia*
Shield cress	*Lepidium perfoliatum*
Tumble mustard	*Sisybrium perfoliatum*
Winterfat (Russian)	*Krascheninnikovia ceratoides*
Wyoming big sagebrush	*Artemisia tridentata ssp. wyomingensis*

Figure 1. At maturity, for a brief period, annual wheatgrass plants have a golden color that is very distinct from cheatgrass. Image taken on Jungo Flat in Humboldt County, Nevada. The infestation is most abundant in the disturbed area along the road but extends well out in the surrounding salt desert vegetation. The green vegetation growing with the annual wheatgrass is halogeton.

Corfu, Washington, was added to list of known sites in the United States.

Botanical History

The botanical authority for *Agropyron triticeum,* Carl Friderich von Gaertner, was an 18th-century German physician and naturalist–botanist. He published the original description in 1770 from collections made in Russia. In 1934, Sergel Nevskii, senior agrostologist at the Botanical Institute of the Academy of Sciences of the USSR in Leningrad, published that the annual wheatgrass was not an *Agropyron* but belonged in the genus *Eremopyrum.* The genus *Eremopyrum* was established by Carl Friedrich Ledebour in his *Flora Rossica* published in the mid-19th century. Despite botanical names being written in Latin, the roots for the names *Agropyron* (*agrios,* wild; *puros,* wheat) and *Eremopyrum* (*erem,* desert; *puros,* wheat) are derived from ancient Greek. The specific name *triticeum* is the ancient Latin word for wheat. The scientific name for annual wheatgrass then becomes the redundant "desert wheat wheat." In the volume of the *Flora Europaea* containing the grass family, the characteristics used to separate the genera *Agropyron* and *Eremopyrum* are 1) that the glumes of the latter are joined at the base (connate), 2) that the rhachis (in the United States rachis, or axis of the spike) of *Agropyron* is tough (meaning it does not disarticulate or fall apart at maturity), and 3) that the *Agropyron* are perennials and the *Eremopyrun* are annuals. The *Intermountain Flora* volume on grasses used the genus name *Eremopyrum triticeum* and gave the distribution in the intermountain area as eastern Oregon, southern Idaho, northern Nevada, and central Utah.

Native Environment

In *Flora Europaea,* the distribution of *Eremopyrum triticeum* is given as steppes and other dry habitats in southeastern Europe from eastern Romania to western Kazakhstan and extending northward into central Russia and southeastward to southeastern Russia. The Bet Pac Dal Desert of Kazakhstan stretches across an immense expanse of central Asia east of the Aral Sea. Virtually every upland plant community that has been described in this desert contains, under the heading of ephemeral annuals, *Bromus tectorum* and *Eremopyrum orientale. Bromus tectorum* is, of course, our familiar invasive weed, cheatgrass. We have no common name for *Eremopyrum orientale,* but eastern annual wheatgrass would seem appropriate. It is a similar species to the annual wheatgrass introduced to North America, but the spike disarticulates at maturity between the individual florets in a manner similar to bottlebrush squirreltail. *Eremopyrum triticeum* is listed as a component of communities with woody sagebrush or winterfat overstories and a perennial grass layer dominated by species of needlegrass. The description of the native range of annual wheatgrass is like a broken record; it could fit most of the exotic, invasive annuals that have marched across the sagebrush/bunchgrass like Woody Guthrie's song about the boll weevil and the cotton patch, "Just looking for a home."

Figure 2. Comparison of mature annual wheatgrass (**A**) and mature cheatgrass (**B**) The sparse leaves of annual wheatgrass disappear at maturity, leaving the naked stems and the upright spike. The spike soon dehisces as a unit, leaving the naked stems. The remnants of the annual plant are nearly invisible unless you look closely at the ground. In contrast, cheatgrass remains highly visible after maturity.

Figure 3. Annual wheatgrass infestation in Dixie Valley in north-central Nevada. At 3,700 feet, this is the lowest elevation in this portion of Nevada. The soil is salt-affected, very fine-textured deep-water sediment from the pluvial lake that occupied the basin during the Pleistocene. The salt desert plant community is Bailey greasewood. Image taken during the summer of 2003 after a winter with less than 3 inches of total precipitation. The annual wheatgrass matured and produced seed. Perhaps even more remarkable is that the cheatgrass under the shrubs in the background also produced seed at this site.

Common Name

The common name of annual wheatgrass is uniquely descriptive for this species in North America because there are no other annual wheatgrasses. The genus in Europe and Asia contains 5–8 species. Apparently, only the single species has been introduced to North America. Many range managers know the weed as "annual crested wheatgrass." This is both to be expected and unfortunate. It is to be expected because the extremely compact spike of annual wheatgrass resembles the much larger head of some cultivars of crested wheatgrass. This comparison is unfortunate because although both species are members of the same tribe of grasses, they are not closely related. Annual wheatgrass is *not* an annual, dwarf form of crested wheatgrass.

Seedling Identification

The most abundant and widely distributed annual grass in the intermountain area is cheatgrass. The problem in identifying seedlings of annual wheatgrass is usually going to be how to separate seedlings of this grass from cheatgrass. If cheatgrass emerges in the fall, it forms flat rosettes of leaves over winter, and by midwinter the leaves often turn at least partially red. We have not observed either the rosettes or the red leaf color in fall-germinated seedlings of annual wheatgrass. The leaves of seedlings of both species tend to be flat, often with a slight twist. Cheatgrass leaves are slightly darker green in color, but this is not a real distinctive difference. The midrib on the underside of cheatgrass leaves is more prominent. The ligule of both species is papery, translucent, and minutely serrate. The Weed Science Society of America refers to downy brome as the common name for cheatgrass. Maturing cheatgrass plants are usually covered with a soft hispid pubescence. This covering is not necessarily well developed in seedlings. There are forms of cheatgrass that are without hairs (glabrous) at any growth stage. On balance, if an annual grass seedling in the intermountain area has hairs on the sheath, especially near the ligule, it probably is cheatgrass and not annual wheatgrass.

Flowering Plant Appearance

As annual wheatgrass matures, it becomes very distinctive. At maturity, annual wheatgrass usually has a more golden straw-colored herbage than cheatgrass (Fig. 1). It is a much less leafy plant than cheatgrass. Unless cheatgrass is severely dwarfed by drought (Fig. 2), cheatgrass is a much taller plant than annual wheatgrass. The tallest annual wheatgrass plants we have seen in the field are around 6–8 inches. On dry years, the plants are often mature at 4 inches in height. On very arid sites, annual wheatgrass may mature and flower at 2 inches in height. Plasticity in morphology is readily apparent in exotic annual weedy grasses.

After maturity, when the seed head drops, annual wheatgrass essentially disappears (Fig. 3). The sparse leaves drop, and the naked stems fade in color until the dead plants are close to invisible unless you look closely. This disappearing aspect of the plant probably helps explain how the plant has invaded so many plant communities with minimum notice in the literature. Unless you visit the site during the couple weeks of the growing season when the seed heads are ripe and before they fall, you are not going to recognize the species unless you look closely.

Seed Head Differences

Annual wheatgrass is absolutely unique in its seed head. The spike is extremely compact with the florets set perpendicular to the central axis or rachis. The entire spike is less than an inch long and half an inch wide. The spike is oriented rigidly upright. This is strikingly different from the nodding open panicle of cheatgrass spikelets.

Figure 4. Spikes of annual wheatgrass on the surface of the seedbed. The entire spike dehisces as a unit. Note that there are both fresh and older spikes in the image. Apparently, the spikes, with seeds, can lay on the ground for more than 1 season if conditions are not favorable for germination.

The most appropriate description for the spikelets of annual wheatgrass is vicious. Press your finger against one of the mature spikelets, and the appropriateness of vicious is readily apparent. The glumes and lemma have very sharp, short, but needle-like awns.

Seed Dispersal

In initial seed dispersal, annual wheatgrass is unique even among the species of its own genus. The central axis of the spikelet disarticulates at the base, dropping the entire spikelet with the seeds (caryopses) intact. The description in the *Intermountain Flora* suggests that dehiscence of the seeds is tardy. In our experience, it is very tardy, with the spikelets containing seed remaining intact on the seedbed in the field for at least a couple years (Fig. 4).

In the greenhouse, seeds of annual wheatgrass readily germinate from intact spikelets. Such germination produces clumps of seedlings that are similar in appearance to those that occur from rodent scatter hoard caches of cheatgrass seeds (Fig. 5).

Seed Germination

Preliminary germination experiments in the laboratory indicate that the germination of annual wheatgrass seeds is equal to that observed in our extensive data bank for cheatgrass. Cheatgrass seeds have long been known to have exceptional germination at very cold and cold seedbed temperatures. This has been proposed as one of the competitive advantages the specie enjoys on rangelands, where moisture is restricted largely to the winter, when temperatures are too low for the growth of most species. Annual wheatgrass is at least equal to cheatgrass in germination at seedbed temperatures near freezing.

Appearance of Seeds

Searching for seeds of annual wheatgrass in a sample of crested wheatgrass would be difficult (Fig. 6). If skilled seed technologists were aware of annual wheatgrass seeds and had access to reference samples, they could probably identify annual wheatgrass seeds as a contaminant of crested wheatgrass seed lots. Some but not all annual wheatgrass seeds are darker at the base. Annual wheatgrass seeds are quite distinctive from seeds of cheatgrass.

Range of Adaptation in the Intermountain Area

The *Flora Europaea* uses the term "occasional species" to describe the distribution of annual wheatgrass outside its native range. Perhaps occasional opportunistic species fits this exotic weed. Given the chance of introduction to disturbed sites, it probably will grow just about anywhere in the intermountain area. We first noticed annual wheatgrass 40 years ago on the University of Nevada campus at Reno. A brief search revealed a distribution stretching northeast from the campus through the unpaved parking lots of the State Fair and Reno Rodeo grounds to vacant lots in residential areas. Pavement, buildings, and irrigated landscaping appeared to have wiped out this population, but it had

Figure 5. Spike of annual wheatgrass that was collected in the field from the soil surface and then placed in moist vermiculite in the greenhouse. Multiple seedlings emerged from the spike without the individual seeds dehiscing from the central axis.

migrated only to suburbia to the red clay soils on the ridge north of Reno and Sparks. Annual wheatgrass is well established in plant communities with yellow starthistle and medusahead.

Throughout his graduate student and professional career in Nevada, Dr P. T. Tueller has been an astute observer of the Great Basin rangelands for 50 years. He associates annual wheatgrass infestations with old crested wheatgrass seedings planted by the USDA Forest Service. These seedings were often placed in the higher environmental potential portions of the big sagebrush zone.

Our extensive surveys of the rangelands of northern Nevada have identified the transition zone between Wyoming big sagebrush and salt desert plant communities as the key environment for locating annual wheatgrass infestations. If you travel in the transition zone and see cheatgrass infestations in Bailey or even some black greasewood communities, you are almost certain to find annual wheatgrass. Shadscale communities with cheatgrass are also good places to look for annual wheatgrass.

Figure 6. A, Seeds of annual wheatgrass. Each seed is about three-eighths to half an inch long. They are very similar in size to crested wheatgrass seeds. Many of the seeds are dark colored at the base, but some are straw colored, very similar to crested wheatgrass. **B,** Comparison of cheatgrass seed (right) and annual wheatgrass seed (left). Cheatgrass seeds are broader and flatter, and the much longer awn persists.

Why Did Annual Wheatgrass Infestations Suddenly Increase?

The classic ecological explanation for the sudden spread of annual wheatgrass on intermountain ranges is the lag phase in exotic species adaptation. As the exotic species grows in new environments, there is gradual natural selection for adaptation to the new site. Gradually, a threshold is crossed, the exotic species becomes invasive, and the populations seem to explode in distribution. Cheatgrass was first considered an incidental species that grew only in agronomic fields and along roadsides in rangeland environments.

Annual wheatgrass may also be a barometer of climatic change in intermountain rangeland environments. These changes could be on a very short-term and reversible scale or reflect longer-term significant changes in environmental potential. It is not obvious, but the expansion may also be a result of subtle changes in management or in wild herbivore or granivore populations.

We have previously mentioned that annual wheatgrass populations tend to disappear once the seed heads fall. Perhaps the increase in population distribution of this weed has been constant and their perception by human observers in a lag phase.

Consequences of Annual Wheatgrass Invasion

Mention the widespread occurrence of annual wheatgrass to field-level land managers, and they invariably ask in a near-panicky voice, "Will it burn?" If you gathered enough of the herbage, you probably could get it to burn, but do not expect to get your hands warm. Annual wheatgrass produces so much less leafy herbage than cheatgrass that it probably is a minimal fuel hazard. During the late seedling stage, annual wheatgrass probably constitutes a minimal forage resource. At maturity, the armed spike eliminates any possibility of consumption by livestock.

The ecological importance of annual wheatgrass is that it illustrates that each seral stage in the continuum from Russian thistle and halogeton to exotic annual grass dominance is not a definite single-species dominance position but rather a true continuum of assemblages of species that can be broadened or made more diverse by new introductions. Each time this increase in exotic, invasive species occurs, the environmental potential of the site, most importantly soil moisture, is more fully appropriated to the exotic species, and the environmental potential available to seedlings of native species is equally lowered. Adding exotic, invasive species makes the process of environmental restoration on rangelands that much more difficult.

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Prescribed Burning Cooperatives: Empowering and Equipping Ranchers to Manage Rangelands

By Charles A. Taylor, Jr.

As we enter the 21st century, the use of prescribed fire in the Edwards Plateau region of Texas and on rangelands in many other regions faces an uncertain future. The rapid increase in population and increased "urbanization" of rangeland has resulted in increased concerns over issues such as air quality and liability when prescribed fire is considered as a management option. These concerns will continue to increase in the future. However, these problems should not lessen our enthusiasm for prescribed fire as a rangeland management practice. In fact, now is the time to become bold and innovative while always remaining prudent in the use of prescribed fire. The objective of this article is to identify the problems and opportunities related to the implementation of a sustained prescribed fire management regime by ranchers on privately owned lands in the Edwards Plateau of Texas.

Historical Perspective

To understand the present and future use of fire, we need to understand its history. Before there were fences, roads, towns and cities, rural fire departments, livestock, and Western civilization, "natural fires" in the Edwards Plateau of Texas must have been awesome. Just imagine the fuel loads that built up and the consequences of a lightning strike starting a fire in July or August without rain following. The fire would start small but quickly spread, driven by the wind from the thunderstorm. Soon the fire would be large enough to create its own wind, sucking in oxygen to feed its appetite for more fuel. Flame lengths would be reaching into the trees from the head fire. Firebrands would be traveling hundreds of feet into the air and starting new spot fires ahead and to the sides of the fire front. Soon the horizon would be covered with smoke and particulate matter, both being lifted high into the atmosphere, possibly enough to create a rainstorm but not enough moisture to put the fire out. The momentum of the fire would carry it across rivers and streams and over the tops of hills and through ravines. Hundreds of thousands of acres would be burned. At night the fire would slow down and almost stop as if it were resting. But the next day temperatures would rise, the humidity would decrease, and the winds increase, and the fire would rekindle and continue to burn across the landscape, seeking more fuel for its ravenous appetite.

Depending on the weather conditions, the fire might burn for days or weeks; only nature would decide its fate. In the fire's wake, untold acres of vegetation and litter would be burned down to mineral soil. The burned areas would look like a moonscape, charred and blackened with no green leaf left for either ant or buffalo. With no soil moisture or rain, the landscape could appear uninhabitable for either human or beast for many months. But the rains would come, and when they did, the perennial grasses with their energy and growing points stored underground would quickly reappear. Liveoak, shinoak, and most other woody plants would also sprout from underground crowns or roots. Recurrent fires were a primary influence stabilizing vegetation composition as grassland or savanna. Species that are intolerant of fire, such as Ashe juniper and prickly pear, were mostly absent from the vegetation.

Summer was the primary fire season. Warm-season grasses generally produce over 60% of their annual growth by the first of August. July and August are generally dry and hot, corresponding with peak lightning strikes and abundant dry fuel, a perfect system for frequent summer fire (Fig. 1). There

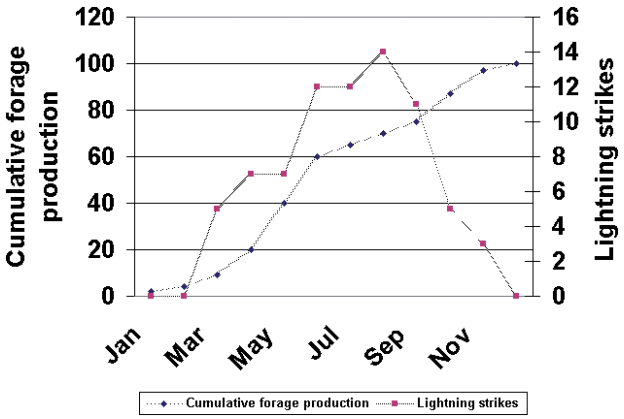

Figure 1. Nature's burning system. Lightning frequency and long-term monthly cumulative forage production for the Edwards Plateau. Lightning frequencies represent the percentage of 24-h periods (days) with two or more lightning flashes per 28-mile grid square 1987–90 (Climatology of lightning frequency – Scientific Services Division, National Weather Service). Forage production determined from various studies on the Texas A&M University Research Station at Sonora, Texas.

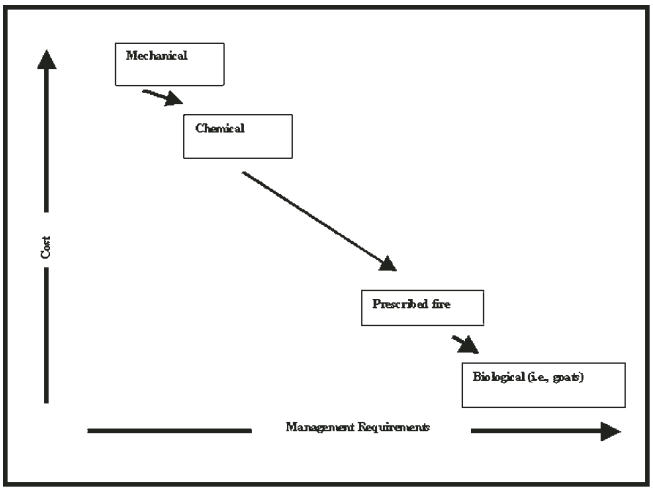

Figure 2. Economics and management required for different management practices.

is evidence that American Indians started fires in the southern mixed-grass prairie in mid- to late summer.[1] The American Indians understood that they had to maintain mostly a grassland for the buffalo to roam.

This landscape was sustained through thousands of years by fires set by lightning and American Indians, but with settlement by Europeans and their descendants in the late 1880s, a dramatic change began. The tall grasses were grazed out, largely fireproofing the range. In addition to the severe grazing pressures imposed on the rangelands, laws were passed by the Texas legislature regulating fire (ie, a law was passed in 1884 that made setting range fires a felony).[2] Also, some ranches began developing fire guards. For example, the XIT ranch began plowing guards in 1885. Within a year, over 1,000 miles of guards, 100 feet wide, had been plowed on the ranch. It wasn't until 1999 that a law was passed in Texas that unambiguously stated that a landowner had the right to conduct a prescribed burn on his or her own property.

With widespread suppression of fire across the Edwards Plateau, woody plants, especially juniper, mesquite, and prickly pear, began to increase in both numbers and cover. Despite many government-sponsored programs and dedicated ranchers trying to eliminate, control, manage, and eventually sculpture woody plants, the "brush problem" continues to return with increasing frequency.

Current Conditions

A major part of the Edwards Plateau is characterized by shallow soil and rocky outcrops that result in discontinuous fuel loads. It's difficult to conduct a winter burn that will suppress juniper and prickly pear. Another factor that makes winter burning difficult in the area is growth of cool season plants and high humidity during mild winters. It is not unusual for winter weather conditions to delay a burning program 3 or 4 years.

Today, dense stands of redberry and Ashe juniper severely reduce forage production, interfere with handling and movement of livestock, degrade wildlife habitat, and waste the water resources of Texas.[3] As economics of ranching becomes tighter, one of the hardest decisions to make is how to manage the forage resource so that the higher-successional, more productive grasses, forbs, and browse can be returned and maintained in the vegetative complex. Another important consideration is budgeting the forage resource (ie, grass) for either livestock consumption or fuel for prescribed fire.

The most widely used approaches to brush management are mechanical treatment and the application of herbicides.[4] However, because these treatments have high costs (Fig. 2) and frequently do not give satisfactory control, interest in the use of fire has increased. The relatively low cost of prescribed fire, both cool- and warm-season fires (multiseasonal), can make fire an extremely viable tool.[5,6] A combination of prescribed fire, coupled with proper grazing management (ie, proper budgeting of grass to either forage or fuel) should offer the best-case scenario for managing undesirable woody plants.

The Application of an Effective Fire Program on Rangelands Is Not a Simple Task

Prior to 1997, prescribed fire was being applied to Edwards Plateau rangeland, but the frequency and numbers of fires were low. Most ranchers were waiting for state and federal agency employees to conduct the burns for them. For example, the Texas Agricultural Extension Service, Texas Agricultural Experiment Station, Texas Parks and Wildlife, and Natural Resource Conservation Service along with universities were helping a few ranchers do some burning. Most of the burns were conducted in the winter or spring, and the results were variable. Very few ranchers were actually con-

Table 1. Guidelines of the Edwards Plateau Prescribed Burning Association, Inc.

1. Dues—$25.00 per rancher per year. Income will purchase, repair, and maintain equipment and support activities such as newsletters.

2. Fire training education—Members should attend a burn school to learn the basics of prescribed fire and receive training on how to operate equipment.

3. Fire plans—Prescribed fires will have burn plans prepared by the rancher and reviewed by Edwards Plateau Prescribed Burning Association, Inc. (EPPBA).

4. Personnel—A critical number of trained personnel will be determined for each burn. The number will depend on the size and complexity of the prescribed burn as described by the prescribed burn plan.

5. Liability—Each rancher will be liable for fires on their property. Proof of insurance is required before the EPPBA will be able to assist on the burn.

6. Fire lines—Each landowner is responsible for preparing their own fire lines. Fire lines will be inspected before the initiation of the prescribed fire and should meet specifications outlined in the burn plan.

7. Equipment—Use of EPPBA equipment will be available to all association members.

8. Fire boss—Each rancher will be the fire boss on their own property unless other arrangements are made.

9. Participation—Members are encouraged to help on as many burns as possible. Participation provides members with fire-line experience, helps them become acquainted with other members with the same goals and objectives, and builds an experienced team. Participation is recorded for each burn. Exceptions are made for members not physically able to actively participate on burns.
a. Officials—Only ranchers can serve as officials for EPPBA (no agency personnel are allowed in an elected, official capacity).
b. All agency and university personnel are encouraged to be members of the association and provide technical advice and assistance.

ducting fires on their own, and most were advised *not* to burn during the hot summertime.

Why Summer Fire?

In the fall of 1997, a prescribed burn tour was held at the Texas A&M University Research Station located between Sonora and Rocksprings, Texas. Data from various research projects were presented at the tour. At the conclusion of the tour, the participants, who were mostly ranchers, were asked which pastures they preferred: summer burned, winter burned, or control (nonburned). The response was almost unanimous for the summer-burn pastures.

After 14 years of conducting prescribed fire research on the Texas A&M University Research Station, summer fire appears to be a viable treatment for this area. Summer fire should be considered a reclamation type burn to be conducted in areas with shallow soil and rocky outcrops and with a significant juniper and/or prickly pear canopy cover.

Generally, winter or spring burns should be considered first, and if it is thought that they will not meet the goals and objectives of a prescribed burn, then summer fire should be an option. For most situations, fuel moisture and fuel load will probably be major factors determining whether a summer or winter burn is needed. Also, target plants are important. For example, juniper and prickly pear are very susceptible to hot fires. Summer fires can raise the temperature of plant tissues to higher levels than winter fires. Most prickly pear plants quickly recover from winter burns.

Why Weren't Ranchers Using Prescribed Fire More Frequently?

If prescribed fire was recognized as a viable tool to manage noxious woody plants, why weren't more ranchers burning and burning more frequently? It was obvious that most ranchers were waiting for agency personnel to do most of their burning for them. Also, many of the ranchers had tried cool-season fires and were disappointed with the results. Most ranchers agreed that major obstacles to an active fire program were liability, insufficient help, and lack of proper equipment and experience. It was clear that ranchers did not need to be "sold" on the benefits of prescribed burning, but they needed to be educated, equipped, trained, and empowered to implement burning on their own ranches. Following the burn research tour, the ranchers were asked if they wanted to form a group of like-minded individuals who would join together to implement a sustainable fire management program.

Most of the tour participants agreed that an association would be beneficial, so by a unanimous vote, it was decided to start a burn association. Nominations were taken for officials, and a president and board members were elected. Guidelines were developed and approved on the same day (Table 1).

Table 2. Rancher obstacles to prescribed burning		
Obstacle to burning	**Individual's response to obstacle**	**Prescribed burn association response to obstacle**
Summer fire	Unable to burn because of burn bans and because burns may not be an accepted practice by all government agencies and universities	Exempt from burn bans because of safety record and training and political clout
Lack of equipment	Buy or rent equipment	Membership pool equipment to help each other; use income from dues, grants, and contributions to purchase more equipment, which is available to all members
Lack of labor to help	Hire labor, but may be difficult to find trained and experienced labor	Neighbor helping neighbor; trained labor force available
Lack of education/experience	Attend schools where available	Opportunity to attend free schools; actual burns to gain experience
Liability	Purchase insurance, but lack of understanding for the need for prescribed fire within community increases risk; difficult for an individual to overcome prejudice against fire	Purchase insurance but manage risk with experienced and trained burn crew equipped with proper equipment; organization has greater political clout within community than individual

The association decided on a name for the organization: the Edwards Plateau Prescribed Burning Association, Inc. (EPPBA). The association started with approximately 30 members but quickly grew to 60 members the first year. The summer-to-winter burn ratio has been 7:1, and there is a good reason for this. Most landowners have tried cool-season burns in this area and found that they frequently don't work very well, especially with marginal fuel loads and/or juniper and prickly pear canopies over 30%. Overcoming the reluctance to burn in the summertime as well as other obstacles have been major factors in the success of the burn association (Table 2).

Figure 3. Edwards Plateau Prescribed Fire boss discussing fire plan with members of the ignition crew.

Providing Education and Experience

Members of the EPPBA are encouraged to attend prescribed burning schools and actively participate in as many burns as possible. Free prescribed burn schools are provided for all members. Most schools are taught or supervised by "lead instructors" certified by the State of Texas in the application of prescribed fire. Ranchers must develop a burn plan for each prescribed burn and prepare their own fire lines. This hands-on fire approach helps build an experienced and trained community labor force (Figs. 3 and 4). Another benefit is a critical mass of like-minded people who have greater political power within a community (ie, the power and historical precedent of individuals joining together to accomplish a common goal is more efficient than individual efforts).

The formation of this neighbor-helping-neighbor cooperative has provided the resources, education, encouragement, and empowerment necessary to help restore fire on a sustained basis. The association was incorporated in 2000. In the spring of 2002, the burning association received the Texas Environmental Excellence Award. This award is presented every year to honor the state's most outstanding environmental projects. Since its founding, the EPPBA has conducted more than 75 prescribed burns on approximately 40,000 acres (Table 3).

The EPPBA continues to grow in size and concept. The organization has received a large grant and numerous cash donations as well as donated equipment, including 2 fire trucks. Originally, the burn association was formed to serve 2 or 3 counties. By the summer of 2003, membership had risen

Table 3. Sample of 1999, 2000, 2001, and 2003 burns conducted by Edwards Plateau Prescribed Burning Association, Inc.

Date	No. personnel	% Humidity	Temp (° F)	Acres
August 18, 1999	12	30	98	200
August 19, 1999	8	32	100	300
August 23, 1999	13	41	90	500
August 27, 1999	10	40	95	900
August 31, 1999	15	32	97	150
September 8, 1999	16	35	90	200
October 5, 1999	17	35	89	546
February 8, 2000	10	25	75	250
March 2, 2000	6	30	85	80
March 29, 2000	14	12	88	878
August 8, 2000	9	32	101	80
August 8, 2000	6	30	101	652
August 30, 2000	29	22	101	965
September 5, 2000	14	25	100	2,000
July 31, 2001	8	28	101	845
August 7, 2001	12	18	101	280
August 9, 2001	8	25	100	300
August 16, 2001	12	27	100	287
August 22, 2001	8	29	97	600
August 18, 2003	13	30	95	560
August 20, 2003	15	29	98	70
August 20, 2003	16	27	94	540

to approximately 200 members who represented close to 1 million acres of ranchland distributed across a 12-county area.

How to Deal With the Growth

Interest in joining the burn association has spread into other counties. As membership has increased, distances between burns have also increased, making it difficult for everyone to participate on each burn. One solution to this problem has been the formation of chapters. For example, separate chapters of the EPPBA have been established in McCollugh County (Brady Chapter), Mason-Llano-San Saba Counties (Central Basin Chapter), Menard County (Menard Chapter), Schleicher County (Eldorado Chapter), and Crockett County (Ozona Chapter). Additional chapters are currently being planned in other counties.

Chapters are a part of the EPPBA (ie, they are governed by the EPPBA bylaws and guidelines), but they also can have their own president and board of directors. Each chapter also has a director who serves on the main board of the parent EPPBA. All membership fees, donations, grants, and so on are deposited in the EPPBA's account, but a separate accounting is kept for each chapter. This allows the individual chapters to determine how they want to spend their money. Board meetings are generally held twice a year to discuss budgets, burn schools, equipment purchases, and grant activities. Field tours are conducted throughout the year to view pastures previously burned and discuss other related topics regarding prescribed burning.

Conclusions

The EPPBA has empowered local ranchers with the educa-

Figure 4. Head fire being set on Edwards Plateau burn near Sonora, TX.

Figure 5. Typical rangeland in the western part of the Edwards Plateau region of Texas dominated by juniper and Prickly Pear. "Happiness is Smoke on the Horizon."

tion, experience, and political clout to conduct prescribed fire during all seasons of the year on a sustained basis. Agricultural associations are certainly not new. The Texas Sheep and Goat Raisers' Association and Texas and Southwestern Cattle Raisers Association are examples of producer organizations that were established early in the 20th century and have served their membership well. Early on, the founders realized that organizing people with like-minded goals and objectives would be more effective than operating as individuals.

All these associations, regardless of size, were organized around a sequence of predetermined steps. They include 1) vision—someone has to start the momentum and take a leadership role and start communicating with other like-minded individuals; 2) organization—the initial meeting with interested parties (ie, ranchers, agency and university personnel, and so on) provides education, information, and ideas on organization; 3) leadership—election of president, board, and other officials; 4) guidelines and bylaws—develop and approve guidelines and bylaws, goals and objectives, and so on; 5) operation—collection of dues, purchase of equipment, writing newsletters, scheduling schools, and so on; and 6) public relations—document benefits of organization to members as well as general public through newsletters and other media outlets.

Based on history, the principle behind the association is proven, but can a prescribed burn association succeed logistically? The EPPBA has developed a logistical model that appears to be successful. Only time will tell, but as long as the goals and objectives of the organization remain relevant and ranchers actually run the organization, the EPPBA should have a "bright" and long-lasting future. The EPPBA is an environmental organization with a long-range goal of sustaining Edwards Plateau ecosystems. Our motto is "happiness is smoke on the horizon." We hope to be putting smoke on the horizon for many years to come (Fig. 5).

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Grassbanks: Bartering for Conservation

By Stephanie Lynn Gripne

Introduction

Over the next 10 years, the Shoshone National Forest in Wyoming will implement fuel-reduction burns on approximately 10 cattle grazing allotments, temporarily displacing up to 13 ranchers from 1 to 3 years. As is the case for many other national forests, a significant obstacle facing federal land managers implementing restoration treatments is the lack of alternative forage for permittees who must remove their livestock from allotments for extended time periods while restoration work occurs. If these temporarily displaced families sold their ranches, which are often large intact tracts of land adjacent to the national forest, there would likely be an increased rate of subdivision contributing to the loss of open space, wildlife habitat, and degradation of forest ecosystem processes such as fire.[1,2] To help support restoration activities on public land and minimize the threat of habitat fragmentation on private land, the Wyoming Chapter of The Nature Conservancy (TNC) has used an irrigated pasture of its Heart Mountain Ranch near Cody as a grassbank to provide forage for permittees whose grazing allotments are temporarily unavailable because of the restoration activities on the Shoshone National Forest.

Grassbanking is a conservation tool that exchanges forage for conservation benefits. In the example of Heart Mountain Ranch, TNC trades forage for a suite of restoration activities. Fuel loads have been reduced (thus decreasing the potential for catastrophic fire), forage quality and quantity have been enhanced and increased for both cattle and wildlife, and the likelihood of habitat fragmentation has been temporarily reduced because ranches remain economically viable and intact.

History of Grassbanking

The term "grassbank™" was coined and registered as a trademark by the Malpai Borderlands Group, a nonprofit organization located in Arizona devoted to restoring and maintaining "the natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant, and animal life in our Borderlands Region." The Malpai Borderlands Group, working on the 321,000-acre Gray Ranch, which is located in New Mexico and owned by the Animas Foundation, has developed several conservation tools, with grassbanking among their most innovative. The term "grassbank" was used to describe the practice where a rancher in need of alternative forage because of drought, or the desire to conduct restoration activities that require temporary cessation of grazing, moved the displaced cattle to the Gray Ranch. In exchange for forage, the rancher placed a permanent conservation easement on their property, which generally restricted development and, therefore, subdivision. The easement is held by the Malpai Borderlands Group, and its value is equal to the forage value the rancher used on Gray Ranch. As a result of this exchange of forage for conservation easements, over 25,000 acres have been restricted from subdivision. Many people associate grassbanking with conservation easements, but the Malpai Borderlands Group has been the only grassbank that has traded forage for conservation easements. All other grassbanks have traded forage for other types of conservation benefits, such as prescribed fire, rest, or wildlife habitat improvements.

While the term "grassbank" is relatively new, the practice of using a forage reserve, custom grazing, or other tools to incorporate rest rotation into a grazing management plan is

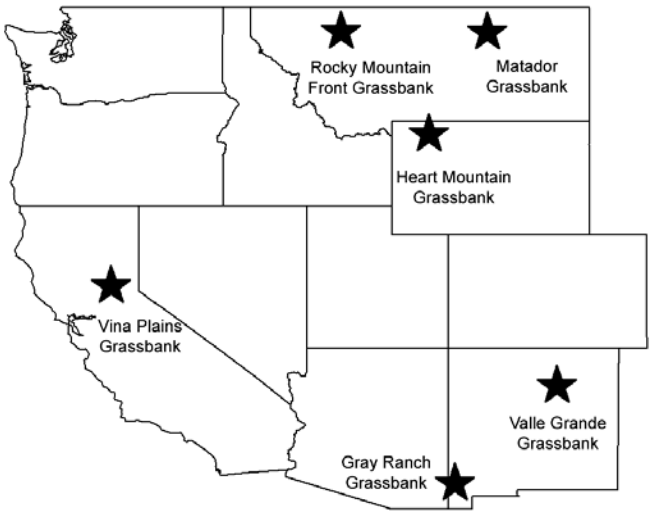

Figure 1. Location of grassbanks throughout the western United States.

centuries old, with examples found across the world, from Canada to Africa and New Zealand.[3] In the United States, the historical precursors to grassbanks were "swing allotments," which were informally implemented by the USDA Forest Service in the first half of the 20th century. More recently, the Bureau of Land Management (BLM) and USDA Forest Service have informally supported similar tools, such as "reserve common allotments" and "forage reserves." Neither "swing allotments" nor "forage reserves" have been formally defined by the USDA Forest Service but are understood to be vacant allotments that can be used by operators in situations when their home allotment is unavailable for grazing for reasons such as rest, natural disasters, or management activities. The BLM has formally defined "reserve common allotments" as areas that allow permittees to engage in rangeland restoration by temporarily shifting their livestock to forage reserve areas. However, in 2004, the BLM chose not to formally adopt this tool. Regardless of the name, all these tools are an attempt to provide land managers flexibility, supporting a type of "third-party rest rotation" for managing their grazing operations in a way that produces both agricultural products and ecosystem goods and services over the long term.

Existing Grassbanks

Because of the perceived potential of grassbanks to help address numerous ecological problems in the western United States, significant amounts of time and money have been invested by organizations and individuals to develop grassbanks (Fig. 1). The 6 longest-running and most publicized include Malpai Borderlands–Gray Ranch Grassbank, Arizona; Valle Grande Grassbank, New Mexico; Vina Plains Lassen Foothills Grassbank[i], California; Rocky Mountain Front Grassbank, Montana; Heart Mountain Grassbank, Wyoming; and Matador Ranch Grassbank, Montana. The Malpai Borderlands–Gray Ranch Grassbank was described previously; these 5 other most well-known grassbanks are described here. Over 17 additional potential grassbank initiatives have been documented as of 2001,[4] and additional grassbanks are emerging in Oregon, Nevada, South Dakota, Arizona, and New Mexico.

Valle Grande Grassbank–Conservation Fund[ii]

In 1998, the Valle Grande Grassbank in New Mexico was formed when the Conservation Fund purchased 240 acres of base property associated with a 36,000-acre USDA Forest Service grazing allotment. The purpose of the grassbank has been the exchange of forage for restoration commitments (eg, riparian restoration, fire restoration, and removal of small diameter timber) by the USDA Forest Service on grazing allotments.[5] This grassbank is primarily a public land grazing allotment that supports restoration work that occurs on other USDA Forest Service grazing allotments.

Vina Plains Lassen Foothills Grassbank–TNC

The Vina Plains Grassbank is owned and operated by a nonprofit organization that supports restoration work on private land. In 1997, the California Chapter of TNC converted its 4,600-acre Vina Plains Preserve into a grassbank to support some local landowners' interest in using prescribed burning to control invasive weeds on private land. The grassbank enabled local ranchers to undertake management practices that reduced the abundance of invasive species in exchange for reduced grazing fees at the preserve.[6]

Rocky Mountain Front Grassbank–TNC

The Rocky Mountain Front Grassbank in Montana is a 320-acre parcel of private land. The local advisory group was enthusiastic about the Malpai Borderlands–Gray Ranch Grassbank model, but obtaining a large-acreage private ranch for the purpose of a grassbank was not monetarily feasible. Hence, the Rocky Mountain Front Grassbank started a small pilot grassbank on private land and intends to create a network of private grassbanks from ranches whose owners are willing to donate or lease forage, thereby forming a collective grassbank for use by local ranchers.[7] In this case, both the grassbank and the restoration work take place on private land.

Heart Mountain Grassbank–TNC

The Heart Mountain Grassbank, located near Cody, Wyoming, is owned by the Wyoming Chapter of TNC. This 15,000-acre property includes 600 acres of low-elevation irrigated pasture that is utilized for the grassbank. Ranchers have used the grassbank when their federal grazing allotments are unavailable to them because of local USDA Forest Service and BLM restoration activities (eg, rest from graz-

[i] At the time of publication, Vina Plains Grassbank was no longer operating.
[ii] In November 2004, the Valle Grande Grassbank changed names to the Rowe Mesa Grassbank and is now associated with the Quivera Coalition.

ing, prescribed burning).[8] Heart Mountain Grassbank is the only grassbank that is utilizing irrigated pasture that is owned by a nonprofit organization, and it currently supports management activities on public land.

Matador Ranch Grassbank–TNC

The Montana Chapter of TNC owns and operates the Matador Ranch in eastern Montana as a grassbank. They use the forage on the 60,000-acre ranch to leverage a variety of benefits, such as the conservation of prairie dogs, sage grouse, sod busting and weed prevention, and sustainable stewardship practices on both private and public land.[9]

Grassbank Associated Research

A decade ago, the term "grassbank" was virtually unknown. In recent years, the grassbank concept has gained momentum and has received increasing attention through numerous popular articles and unpublished scientific literature.[10–15] However, no peer-reviewed literature exists describing or evaluating the effectiveness of grassbanks. The 3 primary descriptive sources of information about grassbanks are conference proceedings from a symposium held in New Mexico in 2001 titled "Grassbanks in the West: Challenges and Opportunities" and 2 Master's projects.[11, 12] The conference held in New Mexico included a diverse group of panelists addressing issues associated with grassbanks. The symposium was sponsored by the Quivira Coalition, the Conservation Fund, the Malpai Borderlands Group, the Northern New Mexico Stockman's Association, the USDA Forest Service, and New Mexico State University's Cooperative Extension Service. The conference provided clarification, assessment, and input about grassbanks and covered a variety of topics, including definitions, policy barriers, funding, and limitations of the concept.

While the conference provided the first public forum to clarify and assess grassbank initiatives, Claire Harper completed the first study of a grassbank, focusing on the Valle Grande Grassbank as a model for nonprofit organizations working in the arena of grazing on federal lands.[16] She documented grassbank challenges, which included 1) the USDA Forest Service completing timely and high-quality environmental assessments similar to those of the National Environmental Policy Act, 2) the USDA Forest Service's development of restoration treatments to ensure a stable flow of participants, 3) obtaining long-term funding, 4) completing restoration treatments in a timely manner, and 5) increasing the role of rancher responsibility.

Edwards[17] reviewed innovations related to conservation and focused specifically on grassbanks. She cautioned against the widespread endorsement of untested conservation strategies, including grassbanks, because such an endorsement could lead to the premature adoption of a conservation strategy that may not be sustainable. Edwards also noted that grassbanks will likely fail without support from public land management agencies and other pertinent institutions with authority to implement policies that enhance probabilities of grassbank success.[17]

Additional research is under way by this author and a team of ecologists, economists, and social scientists representing the University of Montana, the University of Idaho, Colorado State University, The Nature Conservancy, and the National Grassbank Network to address the effectiveness of grassbanking as a conservation tool (Gripne, unpublished data). This research will address questions such as the following: 1) Which grassbank institutional arrangements or models are associated with the least cost and greatest conservation benefits? 2) How can individuals involved with grassbanks economically value conservation benefits in order to ensure an even trade of forage for conservation benefit while avoiding private inurnment issues? 3) What are the biggest practical and policy challenges associated with grassbanking? 4) How do the different place-based grassbank initiatives (ie, Heart Mountain Grassbank in Cody, Wyoming) interact with the larger communities of interest (ie, citizens throughout the United States and the world with a vested interest in the Greater Yellowstone Ecosystem)? This research focuses on similarities and differences among currently operating grassbanks and opportunities to learn from those experiences.

Challenges

As with any conservation strategy, there are numerous ecological, economic, social, and policy challenges associated with grassbanks, chief among these being measuring and defining conservation benefits. Grassbanks are philosophically based on the concept of "quid pro quo" (ie, an equal value of forage is traded for an equal value of conservation benefits). Hence, grassbank participants should provide a measure of conservation benefit associated with restoration activities such as rest from grazing, reintroduction of historic fire regimes, and other specific activities. Grassbank participants must also calculate economic costs associated with achieving benefits. Once costs and benefits associated with grassbanking are known, stakeholders can address the critical question of whether the conservation benefits could be achieved at lower costs using alternative conservation strategies.

Valuing the conservation benefits associated with grassbanking in economic terms is essential to addressing the quid pro quo exchange requirement associated with grassbank operations. However, conservation valuation methods such as contingent valuation, hedonic, and substitution costs, and so on are often time intensive, costly, and controversial. While the notion of quid pro quo is philosophically tied to all grassbanks, this concept is a legal requirement of grassbanks operated by organizations with tax-exempt charitable status under US tax laws (eg, 501[c][3] organizations). In other words, such grassbanks must comply with operating rules established to ensure that tax-exempt organizations are operated for the charitable and public purposes for which

they are established. Specifically, a charitable organization's assets cannot be used to benefit private individuals (ie, private inurnment).

Since a grassbank transaction is based on the concept of an exchange of forage for valuable and specific conservation benefits, the grassbank operator must ensure that the value of the conservation benefits are at least equal to the value of the forage exchanged. For example, if the nonprofit grassbank organization leases forage at a discounted rate to a rancher, it must demonstrate that the economic value of the conservation benefit achieved by the rancher equals or exceeds the value of discounted forage. The nonprofit grassbank organization would need to perform a market and/or nonmarket valuation of conservation benefits (ie, prescribed fire or reduced threat of habitat fragmentation from forfeited development rights) to demonstrate that the values of trade are equal. This task is further complicated when rights obtained from the landowner during the transaction also provide an economic benefit to the landowner (ie, if, by resting the landowner's pasture from grazing or by implementing fire program, certain invasive or exotic species are removed and result in an overall increase in the quality of the landowner's forage); adjustments must be made to account for those benefits.

A policy dilemma that may arise in grassbank transactions relates to the inability of the landowner to claim a charitable contribution deduction for the value of the standing grass. Under current tax law, an individual can donate cut grass in the form of baled hay to a nonprofit organization and deduct the value of the hay as a charitable donation. However, until the tax law is changed, a donation cannot be claimed for the same grass if it is standing. In addition, there are other policy issues specific to grassbanks that operate on public land. For example, restoration projects on public land require appropriate environmental assessments of the consequences of management activities under the National Environmental Policy Act, which has proven to be expensive and difficult to implement in a timely manner.

Finally, perhaps the greatest challenge associated with grassbanking is obtaining adequate funding and resources. Preliminary examination of existing grassbanks indicates that capital land investment ranges from $0 to $8,000,000 and that the annual operating costs associated with grassbanks range from $5,000 to $260,000. People who want to start a grassbank are logically seeking operational and financial resources that are currently unavailable to them in a central clearinghouse or network (Gripne, unpublished data). In response to this need, efforts are being made to establish initiatives such as a National Grassbank Network (http://www.grassbank.net) or Grassbank, Inc., to provide resources and representation for individual grassbanks.

Conclusion

Grassbanking is a tool that provides land managers with incentives and flexibility to pursue restoration activities that require temporary displacement of grazing activities that otherwise may not be feasible. Several grassbank initiatives have begun, and more are contemplated throughout the western United States. While there is a high level of enthusiasm among some land managers and conservation organizations for grassbanks, there are challenges associated with successfully developing grassbanks that remain to be solved. My preliminary research suggests that, in general, grassbanks require substantial financial and administrative resources to be committed over the duration of the project; these costs have, in several cases, proven to be greater than the stakeholders originally anticipated. Measuring conservation benefits and demonstrating associated economic values of those conservation benefits has proven technically difficult. The long-term success of grassbanking depends on how well managers and researchers address the practical and policy issues articulated herein related to grassbanks.

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Historical

Lewis and Clark, Pioneering Rangeland Managers?

By Richard H. Hart

Two hundred years ago, the "Corps of Discovery," as the expedition led by Meriwether Lewis and William Clark was formally known, was well into the Northern Great Plains. They were not the first Euro-Americans to enter this region. Henry Kelsey had been on the Saskatchewan River in 1690 or 1691 and described his travels in verse of awkward rhyme and worse meter.[1] Pierre Gaultier de Varennes, Sieur de la Vèrendrye, reached the Mandan villages on the Missouri River in 1738. His sons, Louis-Joseph and François, traveled up the Missouri from the villages in 1742 and 1743, reaching the mouth of the Teton River.[2] DeVoto describes several other explorations of the Northern Plains before 1800.[3] Representatives of the Hudson's Bay Company and the North West Company had been trading with the Mandan villages for decades before the appearance of Lewis and Clark,[3] and several had left journals.[4] However, none of them showed any interest in the agricultural or stock-raising potential of the Plains.

Curiously, neither did Lewis and Clark. Their primary objective was to discover the shortest route between the headwaters of the Missouri and Columbia rivers. They were also to determine the northernmost reach of the Missouri drainage; to assert American sovereignty over the West and proclaim American authority over its Indian tribes and British traders; and to add to the knowledge of the plants and animals, weather, seasons, and natural wealth of the region. Although this knowledge might be of use in establishing agriculture in the West, this objective was not stated specifically.

In their journals, Lewis and Clark[5,6] continually express astonishment at the immense herds of grazing animals on the Northern Plains. On April 22, 1805, Lewis described "immence herds of Buffaloe, Elk, deer, & Antelopes feeding in one common and boundless pasture" [6] near the present Williston, North Dakota (p. 60). On August 29, 1806, near the mouth of White River, Clark wrote: "I had a view of a greater number of buffalow than I had ever seen before at one time. I must have seen near 20,000" (p. 238).[6]

However, neither Lewis nor Clark made the connection that rangeland that could support such masses of bison could also support large numbers of domestic livestock. On the other hand, Steven Long[7] and John C. Fremont[8] concluded that, although the Great Plains were unfit for crop agriculture, they were excellent grazing lands. However, Lewis and Clark's sighting of large numbers of bison nearly every day and of bison on 19 of the 29 days they spent near the Great Falls of the Missouri casts doubt on the regular migration of bison and the rationale for rotational grazing.[9]

Although they frequently mentioned woody vegetation and the more showy forbs, Lewis and Clark rarely mentioned grass in general, and never, as far as I could find, mentioned a particular species of grass. Perhaps they viewed grass as outside the plant kingdom, as Fremont[8] apparently did when he recorded ". . . hunting plants among the grass" (p. 33). Lewis did complain about the abundance of prickly pear: "The prickly pear is now in full blume and forms one of the beauties as well as the greatest pests of the plains" (p. 383).[6]

Although Lewis and Clark were truly pioneering naturalists,[10] we must conclude they were not pioneering rangeland managers. This is not so strange, considering that our profession is a relatively new one; the Society for Range Management is 60 years old.

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Technology/Methods

What Exactly Are Your Sheep Eating?

Extend the grazing season and reduce supplementation needs of your range flock in just 60 minutes a day.

By Christine W. Royer, R. D. Horrocks, Val J. Anderson, and Steven Monsen

Resurrecting the Range: The Shrub Solution

Various shrub and grass communities occupy much of our western rangelands. The seasonal quality and amount of forage varies considerably among all communities. In some situations, attempts have been made to increase the abundance and seasonal quality of the forage by replacing or altering the species composition. An estimated 12.4 million acres of the total 94 million acres of sagebrush-grass range have been seeded to crested wheatgrass as a means to improve forage conditions, control weed invasion, and reduce the incidence of wildfires. Planting a diverse array of species has been recognized as a means to improve forage quality and extend the grazing periods.

Most shrubs, including species of sagebrush that dominate extensive regions in the West, vary greatly in palatability. Many shrubs are nutritious and are used by livestock and wildlife. For example, black sagebrush is highly regarded as palatable forage for livestock and big game and is especially important to sage grouse. The sagebrushes vary greatly in palatability, though they are quite nutritious. Differences in palatability and selection by grazing animals have been reported for different species of big sagebrush, fourwing saltbush, antelope bitter brush, and many other woody species as well as forbs and grasses.

Researchers have selected highly nutritious shrubs and broadleaf forbs species for a variety of local growing conditions. For example, plant breeding and rigorous selection programs have produced improved varieties and ecotypes of big sagebrush, winterfat, antelope bitterbrush, fourwing saltbush, and numerous broadleaf forbs and grasses. Not all selections have been thoroughly tested for acceptance by livestock as seasonal forage. Some selections may fall short as livestock forage because of the grazing preferences of particular animals.

What We Are Still Wondering: How Much Does Sheep Shrub Selection Shift With Season?

Ranchers need to know the plants being used under free-ranging conditions as well as in controlled pastures and whether supplements are needed. From the sheep rancher's viewpoint, sheep nutrient requirements fluctuate with breed, age, and physiological condition. Similarly, the nutrient content of range grasses and shrubs changes with season and stage of development. Fortunately, sheep have the ability to adjust to these changes and make sound nutritional decisions based on the quantity and quality of available forage. Howery showed that range sheep pick and choose to make a diet more nutritious than the average available.[1] Unlike with confined animals, there is no way for ranchers to know what the daily food choices of the range-fed flock are. However, ranchers may need to feed appropriate supplements for specific periods to sustain animals. Underfeeding or overfeeding the flock can impair performance or waste money. If range sheep managers could accurately calculate the voluntary intake by grazing animals, they may minimize the use of expensive supplements while maintaining animal performance.

Since sheep preferences for shrubs and grasses change throughout the year, scientists have been working on ways to track these changes. Studies of preferences for shrubs have shown in nearly every case that supplementation can be reduced but not eliminated when shrubs are part of the pasture. But reduced by how much? Few studies actually present useful calculations. Even if they did, such numbers would not be universally applicable.

Having faced these obstacles firsthand in a study of sheep forage preferences, we have concluded that while scientists can help in determining methods of data collection and analysis, those who are on the ground with the animals themselves should do the collection of animal preference data. Yes, we are suggesting that livestock producers collect the data themselves. Animal behavior is too often affected by caution induced by unfamiliarity. Much of the variability inherent in behavior studies could be eliminated by using the framework already in place on a working sheep ranch. On the ranch, the nutrient needs of the flock are known, and the nutritional characteristics of the range can be easily deter-

mined by sending samples to a local plant analysis laboratory for routine testing. After a few basic supplies are collected and placed in the glove box or saddlebag, calculation of the range flock ration and any need for supplementation is only minutes away.

The How-To

In animal preference studies, either esophageally fistulated animals or fecal material collected in bags attached to the rear of the animal are needed. Obviously, these techniques are not practical for use by ranchers. But 2 methods of direct observation have been shown to give similar results and are easily adapted to use by almost anyone who happens to be standing in a pasture while sheep are grazing, provided the sheep are accustomed to being watched. Researchers refer to these methods as "focal-animal sampling" and "instantaneous-scan sampling."[2]

A few generalities in using either method should be mentioned. Decide which observation method will be used, then use it consistently in every sampling session. Researchers have found that sheep consistently graze in the early morning or late evening. Observations recorded during 3 morning and 3 evening sampling sessions provide enough data to draw accurate conclusions. Sampling days should be consecutive. If supplementation requirements are to be determined, sampling days must correspond to the time of year when the nutrient content of range forage is known. To obtain reliable data, the observer would select a group of at least 10 sheep from the flock and be able to identify them individually each observation period. Or, if the flock is already divided into separate groups (such as a wether band or a breeding ewe band), a sample of 10 "new" sheep from the same group could be used for each observation session to obtain good data.

Focal-Animal Sampling

In studies of livestock forage preference, this method is alternately referred to as "bite counting." With this method, you can accurately measure what is being consumed by observing only 1 animal (the focal animal) at a time. Researchers often tally the bites of the focal animal for a 5-minute period, recording the number of grass bites, shrub bites, forb bites, and so on. Then another sheep is observed for the next 5 minutes. If the focal sheep stops grazing or is lost from view, the stopwatch is stopped and resumed after grazing commences or the view is unobstructed.

After 10 sheep and 30 minutes, the detailed account of individual sheep grazing activity provides estimates of the percentage of time spent grazing each forage class (shrub, grass, or forb), the bite rate attained in each forage class, and the actual composition of the diet by forage class. Since every bite (the visible and audible taking of food) is counted, it is necessary to approach close enough to individual animals to identify what their mouth is touching. This becomes much simpler if the available forage classes are as structurally different as possible (ie, grass vs shrub), allowing quick identification from a distance. Field glasses may be useful in identifying preference shown by the animals. Instead of using a handheld tally device, a tape recorder may be used and the information transferred to paper at a later time.

Obviously, to get the data in a timely manner, the sheep must be approachable and easily observed regardless of terrain and pasture size. One of the biggest challenges in the use of this method is the gregarious grazing nature of sheep. They may pack so closely as to make it impossible to view them one at a time. It is hoped that this social grazing may be alleviated when sheep are familiar with each other, the pasture, the vegetation, and the observer. In the event that bite counting isn't possible, instantaneous-scan sampling may be the better choice.

Instantaneous-Scan Sampling

This method is slightly less demanding (a handheld tally device is not needed) and can be done at a distance if plants and sheep can be identified accurately. Here, the entire sample of 10 sheep is quickly scanned, and their behavioral states (grazing grass or forb or browsing shrub) are recorded at several predetermined points in time.

Things you need to know: 1) the nutrient needs of your sheep based on their stage of growth, 2) the names of the plants growing in your area, 3) the protein and energy contained in these plants, and 4) how much of each forage your sheep voluntarily eat.

Things you need: 1) paper and pencil, 2) clipboard, 3) stopwatch, 4) handheld tally device or small pocket-size tape recorder, 5) simple 4-function calculator, and 6) 30 minutes at dawn and dusk a few days each season.

Using these items, the observer would set a stopwatch to beep at 1-minute intervals for about 30 minutes' duration. At each minute mark, the observer would record the foraging state of each sheep using symbols of choice. The effect is comparable to that of taking a snapshot of the group with the passing of each minute. In the end, a record of the percentage of time spent in each forage class is determined.

Crunching the Numbers

Table 1 is an example of the kind of information that can be determined from this effort. Once you have determined the nutrient requirements of the sheep sampled (Table 2) and the nutrient content of the range forages for the observation days and obtained an estimate of the proportion of the diet composed of each forage class, an estimate of supplemental feed needs can be calculated.

Simple Dietary Calculations

The percentage, or the ratio (eg, 17%, or 0.17), of each forage class in the diet, whether obtained by counting bites or minutes in each forage class, can be calculated using these simple equations:

$$\%\ \text{shrub} = [\text{shrub} \div (\text{shrub} + \text{grass} + \text{forb})] \times 100 \quad [\text{Eq. 1}]$$

% grass = [grass ÷ (shrub + grass + forb)] × 100 [Eq. 2]
% forb = [forb ÷ (shrub + grass + forb)] × 100 [Eq. 3]

In Equations 1, 2, and 3, shrub, grass, and forb may be expressed as bites (focal-animal sampling) or minutes (instantaneous-scan sampling), depending on the method used to determine preference.

The contribution of each forage class to fulfilling sheep dietary requirements may be calculated thusly:

(% shrub in diet ÷ 100) × (% protein in shrub, grass, or forb ÷ 100) × 100 = contribution to fulfilling protein requirement [Eq. 4]

This formula can be used for each nutrient of interest (eg, protein, metabolizable energy, phosphorus, and calcium).

Next, a comparison of the calculated contribution of the forage and the nutrient requirement of the sheep indicates needed supplement (Table 1). For example, in the spring of 2000, we determined that fourwing saltbush composed 17% of the sheep diet by using the previous calculation. Memmott has shown that shrubs, at this stage of develop-

Table 1. The contribution of grass, shrub, and supplement to fulfilling sheep nutrient requirements for a 150-pound ewe with a single lamb at different stages of production based on the nutrient content of forages and selection measured in each trial of a sheep preference study conducted at the Brigham Young University Sam and Aline Skaggs Research Ranch near Malta, Idaho, from 2000 to 2001

% Crude protein				
Production stage	Requirement	From grass	From shrub	From supplement†
Early or late lactation	13.4* or 10.7**			
Spring 2000		10.94	4.59	0.00
Spring 2001		11.48	3.45	0.00
Maintenance	9.42			
Summer 2000		4.06	5.94	0.00
Summer 2001		5.51	1.32	2.59
Early gestation	9.30			
Winter 2001		3.12	1.97	4.21
Metabolizable energy (Mcal/kg)				
Production stage	Requirement	From grass	From shrub	From supplement†
Early or late lactation	2.40* or 2.10**			
Spring 2000		1.66	0.41	0.03
Spring 2001		1.74	0.31	0.05
Maintenance	2.00			
Summer 2000		1.17	0.68	0.15
Summer 2001		1.59	0.15	0.26
Early gestation	2.00			
Winter 2001		1.26	0.32	0.42

*Early in the lactation period.
**Late in the lactation period.
†Supplement calculations are based on late lactation. For early lactation, required supplementation would be higher.

Table 2. Protein and energy requirements of a 150-pound ewe at various production stages

Stage	% Protein	Metabolizable energy (Mcal/lb)*
Early lactation	13.4	1.10
Late lactation	10.7	0.95
Maintenance	9.4	0.91
Early gestation	9.3	0.91

*Megacalories per pound.

ment, contained 27% crude protein.[3] A simple dietary calculation ([17% shrub ÷ 100] × [27% protein ÷ 100] × 100) reveals a contribution of 4.59% toward the protein requirement of 13.4% for a 150-pound ewe in early lactation or a requirement of 10.7% for a 150-pound ewe in late lactation suckling a single lamb.[4] The shrub contribution added to the grass contribution of 10.94% ([83% grass ÷ 100] × [13.18% protein ÷ 100] × 100) (Table 1) fulfills the protein requirement completely, leaving no need for supplementation. If instead this field were a grass monoculture, the percentage of crude protein in the diet would not be sufficient, and supplementation would be required.

Shrubs Do Contribute to Reduced Supplementation Needs

As illustrated in Table 1, inclusion of shrubs in grass monocultures does reduce the need for supplemental feed. In this example, reductions ranged from 7.5% to 57%. Just how much shrubs may be benefiting you remains to be determined using the methods outlined. Is it worth it? You decide.

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Technology/Methods

Safe Harbor: Helping Landowners Help Endangered Species

By Ted Toombs

Dougald McCormick and his family have long owned nearly 5,000 acres of longleaf pine forest in the Sandhills region of North Carolina, the area where his ancestors settled in 1791. The McCormicks and other Sandhills landowners found longleaf a good income source not only from timber but also, on many properties, from periodic raking of pine straw, which is sold as landscaping mulch. Historically, frequent wildfires maintained these forests, but now that fires are suppressed, a mature longleaf forest depends on landowners to conduct prescribed burns or mechanically control invasive hardwood understory growth.

These same forests are home to the endangered red-cockaded woodpecker. Management for a mature longleaf forest can create ideal woodpecker habitat and also a dilemma for landowners. The McCormicks and other longleaf landowners long ago realized that allowing their pines to mature and controlling hardwood growth could attract woodpeckers to their property and possibly bring them new land use restrictions. Although improving woodpecker habitat was consistent with their land management objectives, these Sandhills landowners were apprehensive about Endangered Species Act restrictions. So wary was Mr. McCormick that his red truck bore a license plate reading "I EAT RCWS."

Nearly 10 years ago, these landowners found a new way to practice good stewardship without incurring new legal restrictions when the nation's first Safe Harbor program was created in North Carolina. Since then, the McCormicks and more than 80 other Sandhills landowners have enrolled a total of nearly 45,000 acres in Safe Harbor agreements with the local US Fish and Wildlife Service office. They have pledged to protect habitat for any woodpeckers that may already be on their property and to restore or enhance habitat that additional woodpeckers may use. In return, they are assured that they will not be subject to any new restrictions if the population of woodpeckers increases on their property.

Those of us who work directly with private landowners may have encountered a similar apprehension toward management that encourages endangered species. The Safe Harbor program was established with these landowners in mind. The basic idea behind a Safe Harbor agreement is that people who do good deeds shouldn't be punished for doing them. And so, in a Safe Harbor agreement, a landowner commits to beneficial management for endangered wildlife, usually restoring or enhancing habitat, and the US Fish and Wildlife Service pledges not to "punish" the landowner with additional legal restrictions for those good deeds.

Many endangered species could benefit from such landowner stewardship. More than half the endangered species in the United States depend on private lands for the majority of their habitat, and many of them require active habitat management to thrive. An example is the Utah prairie dog, which needs openings within sagebrush communities to maintain sufficient forage quantity and quality and to provide visibility for predator avoidance. Landowners can help the Utah prairie dog by using prescribed grazing and brush management to reduce sagebrush density and height. Such management creates a mosaic of sagebrush communities with varied ages and structure used by other species. Pledging to carry out such management practices where Utah prairie dogs benefit may qualify landowners to enroll in a Safe Harbor agreement.

Species that inhabit ecosystems that are created by fire or species whose habitats are being destroyed by nonnative weeds are other appropriate subjects for Safe Harbor agreements because landowners can restore or improve conditions for the species through active management. In many cases, the landowner will reap other benefits such as improved livestock forage or improved habitat for game species from this management.

Safe Harbor agreements do not free landowners of their obligation to avoid harming endangered species already on their property. For example, a landowner who currently has Utah prairie dogs cannot destroy that habitat by plowing the field. However, landowners who create new habitat or improve existing habitat will not face any new Endangered

Species Act responsibilities if their management attracts endangered species to the habitat they create or improve.

When used with state or federal incentive programs, such as those provided through the Farm Bill, Safe Harbor agreements can be a powerful tool to encourage landowners to help endangered species. Natural resource managers working with private landowners should become more familiar with this tool so they can advise them on its potential use. Managers should also learn what management actions can benefit endangered species in their area and how such activities can be made consistent with landowners' management objectives. With these tools, we have an opportunity to overcome landowners' reluctance and apprehension toward putting out the welcome mat for endangered species and in the long run make significant gains toward recovering these species. Nationwide, landowners are responding with enthusiasm; hundreds of landowners have enrolled a total of more than 2 million acres in Safe Harbor agreements.

At the 58th Annual Society for Range Management Meeting in Fort Worth, Texas, a half-day session will be dedicated to understanding the benefits and applications of Safe Harbor agreements by listening to the experiences others have had with the program. The national Safe Harbor program coordinator for the US Fish and Wildlife Service, Julie Moore, will explain how Safe Harbor can be applied in the rangelands context. A discussion will follow the speakers.

For more information on Safe Harbor agreements, contact your local US Fish and Wildlife Service office. Most current agreements are posted in full on Environmental Defense's Web site at the following address: http://www.environmentaldefense.org/go/incentiveslibrary. Much of this article was compiled from the organization's publication "Safe Harbor: Helping Landowners Help Endangered Species," which can be obtained on the Web at http://www.environmentaldefense.org/documents/929_handbook.htm.

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Youth Forum

Forage Productivity of Rangeland Along the Santa Fe Trail in 1846

By Ginger Goodan

Introduction

Are the many accusations of land mismanagement against the common rancher true? This question is the basis of many conversations concerning the status of our rangelands. Union County, New Mexico, located in the extreme northeast corner of the state, is predominantly rangeland, commonly known as the "llano estacado" (high plains). This is a part of the vast short-grass prairies. Grass production is the economic mainstay of the area, with economic gains arriving from livestock and wildlife production. The major forages are blue grama grass and western wheatgrass, with a scattering of other forages, ie, small bluestem, fescues, and various forbs.

A topic of major concern in the area is rangeland health. With the presence of the Kiowa National Grassland and the new awareness of rangeland health by environmental groups, the topic of improved rangeland is often an item of concern and conflict.

According to the rhetoric of some environmentalist groups, this rangeland is in extremely degraded condition compared to the time when large herds of buffalo roamed freely and settlers were arriving to live in the area.

Are the ranchers abusing the land or improving it? I believe that the range conditions along the Santa Fe Trail have improved since the pre-settler period (1830–1850).

I wanted to find out if there has been a change in the condition of the rangeland from the time when settlers traveled through the area along the Santa Fe Trail in search of a new life. To show this point I had to first document the range conditions along the trail at the time of the pioneers. There is very little scientific information on the plant life at that time. We must depend upon the few written records that have survived. This information is very limited.

Plant life was of great importance to the settlers. They were directly dependent on the plant life and water for their survival. Not only did they use plants to nourish their livestock, but plants were also used for many of their material needs. Some of the plants were not well known. The settlers were not familiar with the area and they were unsure if the types of plant life were edible or poisonous.

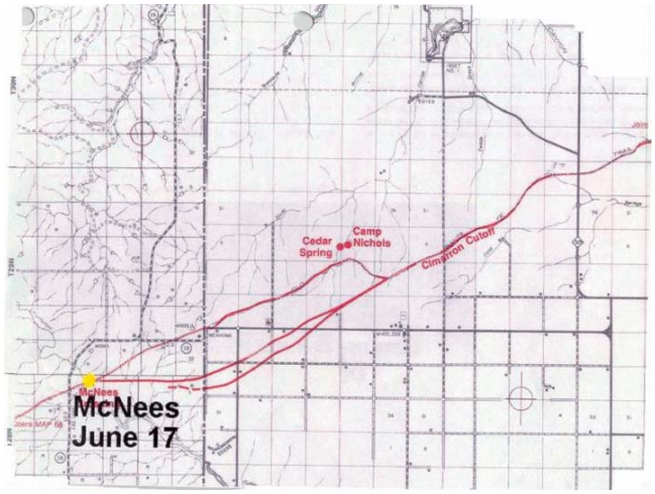
The vegetation was vital to determining where the settlers would settle. Agriculture was the main enterprise of the people who traveled along the trail. Very seldom did you find any other type of person. Ambition surged throughout the wagon trains, and there was a fierce sense of competition among the settlers in the race to find the best grassland and water. As you see, this factor determined who succeeded and who failed on this life-altering embarkment. Good plants meant survival. So, not to my surprise in reading the documentation of the trip along the trail, the terms "good grass, good water" were the most common descriptions of the vegetation.

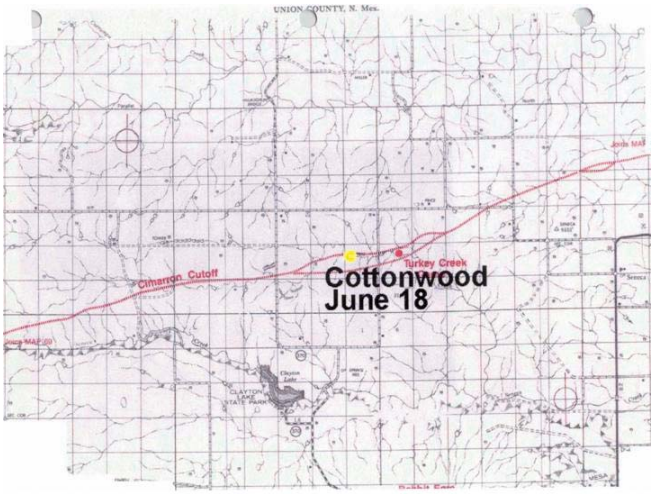
Santa Fe Trail

The Santa Fe Trail was started in 1821. Its primary use was for the merchants in Missouri to trade with the Indians in Santa Fe; in exchange for their goods, the merchants received furs. In 1846, the Mexican-American War began and the armies and cavalry began to use the trail on a regular basis. In 1848, the Treaty of Guadalupe Hidalgo was signed and the war came to an end. When this treaty was signed, the United States acquired more territory, and this territory included the Santa Fe Trail.

After this, the trail became a tool for western expansion, and many people traveled the trail in search of gold in California or Colorado. Trading still continued to take place. When traveling along the trail the wagons were heavily packed, with all the goods their wheels could support, and many of the wagons had livestock tied to the end. The settlers had a rough time along the trail, traveling from dawn until dark. The trail was treacherous and long. It stretched over 900 miles, and the wagon trains faced inclement weather and flash floods, and the settlers themselves faced disease. Many settlers died of hunger and disease. The only signs of human life on the trail were forts, and even those were few and far between. Many settlers were informed about where and when to stop, and landmarks such as the Point of Rocks were well-known sites among the settlers.

There are two branches of the Santa Fe Trail; the Mountain Route and the Cimarron Route. The Mountain Route ran along the Arkansas River and went through Colorado before dropping down to the Raton Pass; from there it traveled through many other sites and then went to Watrous, New Mexico. The Cimarron Route was shorter, and cut the travel time by roughly 75 days. This route traveled through Kansas and entered New Mexico at McNees Crossing, proceeded through Union County, and on to Watrous, where the trails met. Where the trails meet at Watrous New Mexico, the ruts of the wagon wheels are deep. The trail was a huge part of western expansion for over 60 years. In 1987, Congress declared the Santa Fe Trail a National Historic Trail.





Excerpts from Doniphan's Journey Records[1]

June 18—In the afternoon we passed to the right of the rabbit-ear mounds, whose resemblance to rabbit-ears, with some stretch of the imagination, one may discover very easily, and arrived on Rabbit-ear creek, a camp with good grass and water, and cotton-trees and willows along the creek.

June 19—On the top of the mountains grow cedars. TE rocks composing it appear to be basaltic, in a state of decomposition; they look brown, and are sometimes very compact-sometimes more granular and friable. On Rock creek I saw the amygdaloidal basalt again in situ, with its underlying sandstone.

June 20—In the morning we made but five miles, to Whetstone creek and halted, with good grass and water. The sandstone here contains some lime, and may be used for coarse whetstones. The amygdaloidal basalt which I found near our noon camp, is intermixed with silicious particles, glittering with like mica. In going to our night camp we passed extensive strata of yellow quartzose sandstone, dipping gently towards the northeast.

June 21—The Rio Colorado is a clear mountain stream, with fine grass and good soil; cedars grow on the neighboring hills, and further down the creek.

Procedure

First and foremost, I had to acquire some sort of documentation of range condition along the Santa Fe Trail back in the 1800s. Acquiring the documentation proved to be quite a challenge, until Dr Kelly Allred of New Mexico State University found a book written by A. Wislizenus, MD.[1] The book was written from a diary of Colonel Doniphan, who traveled along the trail in 1846 and 1847.

Dr Allred mailed me all the information that he could find. When reviewing this information, I found it to be very precise for that time period, and among the information was a map with Doniphan's campsites plotted on it. The map proved to be very helpful, but to find the exact steps that Doniphan took on his trip, I needed more detailed maps. To do this, I contacted people who were experts in the field. I proceeded to call the Santa Fe Trail Association, in Santa Fe, New Mexico; Capulin Volcano National Monument; and numerous other organizations. I did acquire maps after a few weeks. I laminated them and set them up in the Ag room. I also met with my mentor, David Graham, for a few hours. Once I had acquired the maps I began to attempt to plot Doniphan's campsites on the more detailed maps for a more precise location. I then contacted Harry Myers, who is associated with the Santa Fe Trail Association. He helped me on my journey to plot these points precisely. He did this by sending me maps that have county roads on them, and that access the Santa Fe Trail.

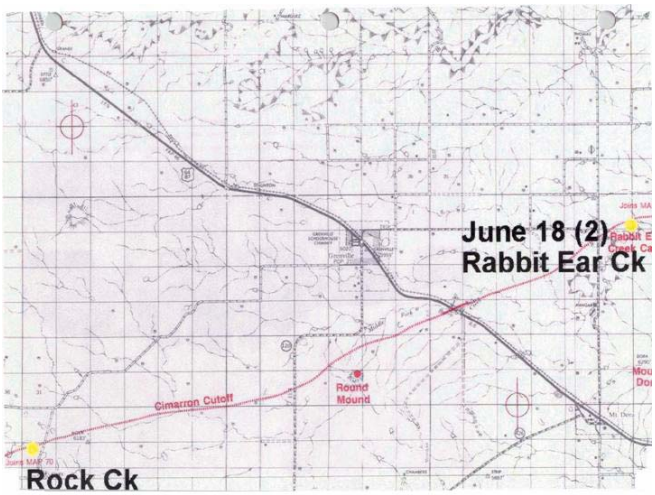
I began to visit the sites and identify the forage both on and off the trail. I gathered samples of the vegetation for protein content analysis. The samples were dried, crushed, and ground. The nitrogen content in each sample was determined using a LaMotte Soil and Plant Tissue Testing Kit. Some typical mapped locations and views are shown in the figures.

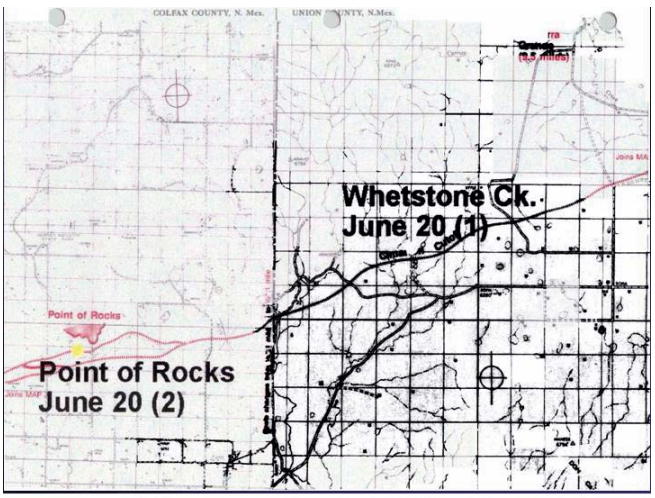
Findings

The results of the vegetation sampling at selected points along the Trail are presented in Table 1. These data represent

Table 1. Forage quantity and quality at selected points along the Santa Fe Trail

	Quantity (pounds per acre)		Quality (% protein)	
Site	On the trail	Off the trail	On the trail	Off the trail
McNees Crossing	1,050	630	16–20	10–16
Cottonwood	770	750	<10	10–16
Rabbit Ears	250	435	<10	<10
Rock Crossing	90	250	10–16	16–20
Whetstone Crossing	60	70	10–16	16–20
Point of Rocks	30	40	<10	10–16





a point in time at each location. Still, I found that the forage quantity was high, with high protein content. According to the experts I interviewed, what Doniphan was accounting for was the ability to use grass for livestock or other production reasons. Even then the grass was not very good, it was just good enough.

What does this mean? Based on the comparison of Doniphan's report and my findings, I would consider the rangelands to be in a better condition now than when Colonel Doniphan was in the area.

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VIEWPoints

The Semantics of Sagebrush

By Jim Brunner

Only recently have wildlands workers found that some sagebrush species are palatable and should be recognized. Back in 1972 I authored an article on sagebrush that was printed in the *Journal of Range Management*. I described a tall sagebrush that was highly palatable and called it "widelobe." At that time I speculated that this might be a tall ecotype of Wyoming sagebrush (Beetle). But someone in the Natural Resources Conservation Service coined the term "Wyoming big sagebrush" and from then on all large intermountain sagebrush were lumped as one species.

Fast forward to December 1999. Enter Dr Durant McArthur of the US Forest Service shrub lab in Provo, Utah. He examined "widelobe" with the help of Stewart Sanderson, University of Nevada, and Dr Jim Young of the USDA Agricultural Research Service, Reno, Nevada, and named the plant *Artemisia arbuscula longicaulis*. He also suggested a common name of "Lahonton sagebrush."

The new nomenclature was not immediately recognized by field workers. A recent sagebrush article in *Rangelands* (February 2004) by Mike Frisina and Carl Wambolt described "widelobe" and called it *Artemisia tridentata wyomingensis*. The only problem is that the plant that Dr Beetle named *wyomingensis* is a small (10-inch-tall) sagebrush that has very distinctive leaves in that the center lobe is too wide for the slot between the 2 outer lobes. *Wyomingensis* seems to grow only on sedimentary soils. An identical plant that grows on shallow red rock volcanic soils is distinguished from *wyomingensis* by its odor; the crushed leaves smell like brake fluid. The vegetative leaves of Lahonton sagebrush are illustrated both in my article and in the recent *Rangelands* article. The Lahonton leaf is long and gracefully curved with a distinct "V" on its upper side.

So could we please drop "Wyoming big sagebrush" from our vocabularies (mainly because there isn't any such thing)? Lahonton is a nice term that rolls easily from the lips. And while we're talking about big sagebrush, please be assured that any stand of tall sagebrush in the intermountain basin is guaranteed to consist of about one-half Parish's sagebrush, *Artemisia tridentata tridentata parishii*, with the rest being a mix of predominantly Lahonton sagebrush, with some *Artemisia arbuscula xericensis*, or blackbark sagebrush (as named by Dr Al Winward), plus some "whitebark" and "no-lobe" unnamed sagebrushes.

Parish's sagebrush is unpalatable, but it makes large amounts of seed and therefore probably furnished most of the available sagebrush seed. It is notable for its yellow anthers, which gives the plant a yellow cast when in full bloom. Lahonton seed is largely unavailable because constant grazing reduces seed production. One can identify Lahontan sage from 100 feet away because of its hedged appearance. ◆

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Thad Box

Grassland, Earthsongs, and Exurbia

A recurring theme in my writing has been that we must listen to the land. We hear its songs of happiness or groans of pain as humans stroke it with their varied uses. When we hear cries of anguish, we attempt to rescue it with our science and action programs. We design new research to produce lyrics for the earthsongs we hear. We develop educational efforts to teach both private owners and government agencies about how science can heal wounded land.

Range management came into existence when overgrazing and drought stripped the land of its protective cover during the last half of the 19th century. Pioneer botanists heard the earth scream and our founders spoke elegantly. Concepts of ecological management of native ranges developed and were tested by controlled experiments. Gradually, we became the authorities on overgrazing, the causes of deterioration, and the conditions of stability.

Perhaps the range profession was born to write the grand opera of herbivory's interaction with people and land. The stage was set for the cries, groans, and yells screamed by eroding land to be answered by passionate, powerful voices of science. Earthsongs detailed the drama of destruction and resurrection, insanity and reason.

In the early days, efforts were directed overwhelmingly toward seeking ways for the interaction of domestic livestock and rangelands to become economically sustainable. Somewhere along the way earthsongs were replaced by cowboy ballads. Many of our lyrics and music reflected what we heard from people seeking wealth, not from voices of the land. But all rangelands were not suitable for commercial livestock production, and rangeland use changed in ways our founders never imagined.

A little over a decade ago, Bob Whitson was appointed range department head at Texas A&M. The department arranged a retreat and the faculty, clients, and friends got together to assess the department's program and examine future needs of Texas' rangelands. I was invited to be part of my alma mater's self-examination.

The assessment of the department's past was a celebration of success. Texas has the nation's most rangelands, almost all in private ownership. Some of the oldest, largest, and best-known ranches are there. The department had an admirable record of working with ranchers. It had good faculty who did practical research. Its graduates filled important jobs in both the public and private sector. Looking back at its past, it appeared all that was needed was some fine-tuning.

However, when the group looked at what was then present, they saw that Texas had changed. The number, and total acreage, of large commercial ranches they served had decreased. Many counties that were ranching areas when the department was established had become bedroom communities for metropolitan areas. Ranches had been cut into "ranchettes," made into housing developments, or otherwise changed from livestock production. Even the commercial ranches were making more money from leasing hunting privileges than from domestic animals.

Commercial ranches were still important, and the department needed to continue to serve them. But rangelands were being used for different things. Many of the properties were too small to carry the ponies and emus that were kept on them. It was obvious that if the department continued the way it had been in the past, it would speak for a declining percentage of the state's rangelands. Its potential for service would be lost by looking in the rearview mirror.

I left the retreat pleased that my alma mater had forced itself to look at actual rangeland use instead of living in the past. I'll leave it to someone from Texas A&M to write about their successes and failures in addressing the needs of changing Texas rangelands. But our profession should look at both their successes and their failures, and learn from them. It is especially important to know why their failures failed. Or why they decided it was not their role to address some apparent new rangeland needs.

One of the most important measures of the value of range professionals is how well we adapt to the changing use of the land we serve. Our choice of which lands to address and which ones to leave for others will not only define us for future generations, it may well determine whether we survive as a profession. Not only must we listen to land, but we must also listen for signals of major societal changes.

A new land-use category has emerged: exurbia. Most of us know that people in the sprawl of upscale homes beyond suburbia voted heavily for President Bush. Houses nestled among the pines on western ranges are front-page news during fire season, and taxes must be raised to bring basic services to the scattered mansions.

Most of our discussion about this spreading land use has been political or economic:

Who lives there? How do they vote? What does their lifestyle cost the taxpayer? Who subsidizes their existence?

Exurban sprawl raises important questions for the range profession: How small a chunk of rangeland will we defend? Will we claim rangelands only if it produces a commodity?

Are small parks of natural "open space" our responsibility? Are 5 acres of native grass cut by a riding lawn mower considered rangelands? Would city lots managed by ecological principles or those managed by turf agronomy be better for environmental quality?

If we decide to accept the responsibility of applying ecology to all land, other questions are raised: How will we restructure our research to serve small, noneconomic pieces of rangeland? Is social science research such as evaluating golfer acceptance of buffalo grass fairways range research? Must something eat the vegetation for us to claim it as rangeland?

Is biological control of insects on exurban lots part of the grand opera of herbivory? What about maintaining ecological balance of native animals and plants on national monuments? Is increase of King Ranch bluestem in road rights-of-way and other ungrazed areas a range problem?

The grand opera of rangelands is ever expanding. We should not, cannot, abandon the fiddle tunes of the old West. But in exurbia the land is screaming loudly as it is torn asunder by big yellow backhoes. Its wounds are covered with Band-Aids® of concrete and asphalt. Land is treated with insecticides and chemical fertilizer and groomed with mowers gulping fossil fuel. How we use our science and our ecological experience to write new melodies of sustainability for land so treated will determine who we are, what we call ourselves, and if we should exist in today's world. ◆

The State of the Range Curricula

By Wayne Leininger

Range programs across the country are generally struggling to maintain adequate enrollment to remain viable entities during periods of fiscal restraint. One of the questions that is being raised is whether the range curricula meet the needs of the students and employers in the new millennium. To help answer this question, I recently surveyed the schools in the United States that offer degrees in range management/science. The following summarizes my findings.

History of the Range Curriculum

Arthur Sampson presented the first formal range curriculum in 1919. It included 21 semester credits in a range management core. Interestingly, at this time only the University of Idaho and Montana State offered degree programs in range.[1] In 1951, the American Society of Range Management Civil Service Committee recommended that students take 10 courses in range management. Eleven years later, the Range Science Education Council proposed a range management core that included 16 semester credits. More recently (1978), the Society for Range Management (SRM) set a standard of 18 semester credits of range management courses for institutions to be accredited by SRM. This is the same number of credits required by the (1994) Office of Personnel Management for the Rangeland Management Series (GS 454). For a more complete history of the range curricula, see McClaran.[1]

Do Universities Differ in Their Requirements?

I found that 21 schools in the United States have range programs. Nine of the schools are in private land states (mostly "plains" states having a small amount of public land, eg, Nebraska), and 10 universities are in public land states (schools in states with a considerable amount of Forest Service and Bureau of Land Management lands, eg, Utah). The universities in the private land states required an average of 128.8 total credits to graduate. In comparison, universities in public land states averaged 6 fewer credits (ie, 122.2 credits). However, universities in the public land states required 4 more credits in range courses (23.1 vs 19) than those in private land states.

Have Range Schools Deemphasized Field Courses?

Heady[2] noted that graduates in range management must be able to recognize and understand the field evidence of vegetation changes and ecological processes. However, because of budget constraints and so on, few range courses now have field components. Texas A&M University, however, requires 11 credits (27 contact hours) of labs in range courses. I noted that only 3 range schools have summer camps, Colorado State University being one of them. In 1999, Harold Heady reported in a *Rangelands* article that "reduction of field experience in university curricula is a mistake."

What's in a Name?

Curricula at a university serve 2 purposes: recruitment and placement. At Colorado State University, we offer courses titled Rangeland Improvements, Rangeland Planning and Grazing Management, Grass Taxonomy, and so on. Some of the other universities (particularly Oregon State) have been a little more creative in titling courses. For example, they offer courses such as Arid Land Biomes, Wildland Ecosystems, Rangeland Vegetation Manipulation,

Plant–Herbivore Dynamics, and so on. Faculty at Oregon State University believe that enrollment in their range courses went up when new names were chosen.

General Observations

Four of the 19 schools surveyed required that students take a Geographic Information Systems/Remote Sensing course. Only 5 of the schools offered a Riparian Ecology course (all public land schools), and less than half of that many (ie, 2) required students to take a Fire Ecology class. Many of the schools have reduced the number of required credits in recent years because of budget and other concerns. Not too surprisingly, however, is that there is a very high level of similarity among all range management curricula sheets.

Summary

I believe that range-trained graduates are in high demand in the job market. Nearly all of Colorado State's range graduates in the past decade have found employment in their field. I also feel that the range curricula in the various universities are designed to provide the proper academic training for graduates to be successful. However, the reality is that enrollment needs to increase in most range programs in order to remain viable. At Colorado State, we are evaluating whether course titles, concentrations, and so on need to be changed. For example, we are going to explore the feasibility of adding a concentration in wildlife habitat management within the rangeland ecology major. We believe this concentration will be attractive to students wishing to emphasize this area of wildlife management. Faculty at the various universities would appreciate any suggestions that members of SRM can provide to improve our curricula to better meet the needs of employers and help in recruiting students into range management/science programs.

References

1. McClaran, M. P. 2000. History of the range curriculum: are there new trails? *Rangelands* 22(6):23–27.
2. Heady, H. F. 1999. Perspectives on rangeland ecology and management. *Rangelands* 21(5):23–32.

Author is Professor, Forest, Rangeland, and Watershed Stewardship Department, Colorado State University, Fort Collins, CO, and 2004 President of the Colorado Section, Society for Range Management.

Fifth in a Series: Insight From SRM's Charter Members

The Society for Range Management (SRM) History Committee has conducted interviews with many of the Society's charter members to capture their perspective of events leading to and subsequent to the formation of the American Society of Range Management in 1947–1948. Interviews from several of these individuals will be shared for today's SRM members to enjoy and learn from.

SRM Charter Member – Paul F. Gilbert

Editor's Note: Bill Hurst conducted a telephone interview with Paul Gilbert on March 4, 2004. Paul can be reached at PO Box 24, Hot Sulphur Springs, CO 80451.

I am 88 years old. I was born in Colorado Springs, Colorado, in 1915. My father was a district forest ranger with the US Forest Service on the San Isabel National Forest, so I was raised in a Forest Service family and early on in my life I had aspirations of becoming a member of that organization.

I graduated from Colorado State University in 1940 with a degree in forestry. During this period I worked 3 seasons for the Forest Service as a member of a range survey crew on the Pike, San Isabel, Roosevelt, and Cochetopa national forests.

During World War II, I served 4 years in the Army, 1942–1946. After discharge from the military in 1946 I went to work with the Colorado Game and Fish Department and completed a 32-year career with that organization, retiring in 1973. In setting big game hunting seasons during this period of time, the recommendations of the field men had to include an assessment of winter range conditions. These ranges were and are critical to the welfare of big game animals.

In 1948 I joined the American Society of Range Management (ASRM) as a charter member. Clint Wasser was responsible for acquainting me with this budding organization and encouraging me to join. I was in full agreement with the objectives of the new Society. At that time I thought that both the national forests and the public domain were being overused by domestic livestock, and I was hopeful the ASRM would be helpful in encouraging better management by all concerned. In this respect I believe my expectations for the Society have been fulfilled.

I believe the Society has stayed on track over the years and has improved its programs and its influence. I am proud to be a member and to have been a part of the organization since its beginning.

I have never served in any major office in the Society but have been a faithful member since its inception.

SRM Charter Member – Howard R. DeLano

Editor's Note: Tom Bedell compiled the information mailed to him in February 2003. Howard DeLano lives with his wife, Pearl, at 17572 S. Hattan Rd., Oregon City, OR 97045.

I was born July 4, 1913. I retired from the Bureau of Land Management (BLM) in 1972 after 33 years with the federal government, including 3 years in the US Navy during World War II. I now own and operate DeLano Farms, LLC. During 1947 and 1948 when the ASRM was organized I was employed as a range conservationist with BLM at Vale, Oregon. I was assistant district manager and largely involved in range adjudication work.

I graduated from Oregon State College (OSC) with a major in forestry and a minor in range management. My range management professor was R.G. Johnson, who started the range courses at OSC. I worked on range surveys with the US Forest Service (USFS) in the summer of 1937. In the latter part of the summer I worked on approving range project work for the Agriculture Adjustment Administration. This work created further interest in range management work.

I became acquainted with Joe Pechanec of the USFS and other people interested in range management. I met with an

organizing group for the ASRM in Pendleton, Oregon, and joined the group. As I remember that was sometime in 1947. I was on the program for the first section meeting that was in Baker, Oregon. My subject was "The Establishment of Grazing Allotments and Developing Management Plans." I joined the Pacific Northwest Section of the ASRM when it first started, which must have been about 1948. I have been a member of this section ever since.

I did not attend the first meeting in Salt Lake City. However, someone sent me records of this meeting. I remember John Clouston sending me some information but I do not remember exactly when.

In 1948 I expected the ASRM to provide support for good range management and to educate people on the subject. I hoped it would provide a means for various interests to exchange ideas and cooperate in the use, protection, and improvement of rangelands resources. The ASRM has been very helpful in these endeavors.

After graduating from Oregon City High School in 1930, I did farm work and was a telephone lineman for the local telephone company. I started college at OSC in 1935 and received my BS degree in forestry. My first summer work while attending OSC was as a fire lookout for the 1936 summer on Black Butte in the Shasta National Forest in California. The summers of 1937 and 1938 were spent largely working on range surveys and some fire fighting. In 1939 I received a civil service appointment as a junior range examiner with the US Grazing Service in Burns, Oregon. That summer I worked on range surveys in the Drewsey Unit. I also worked out of Jordan Valley and Baker for the Grazing Service.

I joined the US Navy in 1942 and received my officer's commission as an ensign. After being moved around a bit, I ended up in the Aleutians as port director for Chernofski, Alaska, the port for Fort Glenn, Unmak Island, which had some 5,000 men. My job included giving sailing orders to mostly cargo ships headed for the Asian theater of war. Chernofski was a turning point for the ships.

After returning to Seattle I was discharged from the Navy. I went back to work for the Grazing Service, which soon became part of the BLM. I worked as assistant district manager in the Vale and Baker Districts. I acted as the district manager of the Jordan Valley District until this office was closed and consolidated with the Vale District. I then acted as district manager of the Vale District while Arch Hanson was in Salt Lake City for about a year having heart surgery.

I was appointed district manager of the Burns District in 1953 and served in that capacity until the fall of 1958 when I became a watershed specialist at the BLM Area Office in Portland. The area encompassed California, Oregon, and Washington. In 1960 I was appointed chief of Range, Watershed, and Wildlife for the Oregon–Washington state office. One of the highlights of my term in this job was to establish positions in Wildlife, Hydrology, and Soils and to hire men with doctorates in each of these specialties.

During my work in the area and state offices in Portland I was encouraged to participate in ASRM activities. I served as president of the Portland chapter and also the president of the Pacific Northwest Section. I served as vice chairman and later as chairman of the Range Equipment Committee of the national group. I attended most of the national meetings during the time I worked out of Portland. I also served time as president of the Portland chapter of the American Society of Soil Conservation. I retired from the BLM in July 1972.

From 1958 to the present time I have been actively raising registered beef cattle and farming. I now operate and manage 302 acres of farm and forest land in Clackamas County, Oregon. I served as president of the Clackamas County Livestock Association and as a vice president of the Oregon Cattleman's Association. I have also served as president of the Oregon Polled Hereford Association and president of the Oregon Gelbvieh Association. We have shown our cattle at the various fairs. We have had the Gelbvieh Cow-Calf Champion at the Calgary Stampede (Canada), the Supreme Champion Gelbvieh female at both the Cow Palace (California) and the Northern Inland Livestock Exposition in Billings, Montana. We have had the Grand Champion Gelbvieh bull 3 times at the Oregon State Fair along with many other winnings. We have operated over 80 registered cows in our herd but are now down to 43 registered Gelbvieh cows.

The SRM has overall performed a good job. Its members have been largely employees of government agencies and university people. It would strengthen the Society if more of the private sector were members, including wildlife, livestock, and business interests.

Interested young people should include range management as part of their studies in high school, and even in grade school.

SRM Charter Member – Weldon O. Shepherd

Editor's Note: Weldon O. Shepherd lives at 203 Tuxedo Drive, Thomasville, GA 31792.

I had been working for the Forest Service for about 7 years when the American Society of Range Management was organized in 1948. My work was with the Southeastern Research Station at Tifton, Georgia, and Raleigh, North Carolina. It seemed important that I participate in this new organization.

Anyone raised in Utah cannot help but be interested in land and water conservation. After graduating from high school in Nephi, Utah, I attended Brigham Young University for 1 year and then went to Utah State University, where I received a BS in forestry in 1937. Working toward graduate degrees, I received an MS in 1939 and a PhD in 1951 from the University of Nebraska. During this period I had the opportunity to do some research and to cooperate with other universities. Some of the work started in Nebraska was a survey of Sandhills rangeland and game management. At Colorado State I was interested in foothill and mountain meadow ranges. A brief period at Wisconsin was spent assist-

ing in instruction in forage crops and pasture management.

In 1940 I took a position with the USFS at Tifton, Georgia, where my research concerned tree–forage relationships on grazed forestland. This involved establishing experimental plots and studying density and species composition, forage types, poisonous plants, and range conditions in Ponderosa pine–cane type areas. The years 1942–1945 were spent in the US Navy Joint Intelligence. During this period I worked with Dick Hurd, also a charter member on the Society for Range Management.

Upon my return to the Southeastern Station I spent 6 years as a forest ecologist concerned with grazing in relation to timber management, watershed protection, timber production, and fire control. In 1952 I became chief of the Range Division in the Southeastern Forest Experimental Station.

After 1951, I served as assistant director of the Division of Range Research in the Washington, DC, office of the Forest Service, where I worked with Division Chief Joe Pechanec, a familiar name in the Society for Range Management. Later I moved to Ogden, Utah, as director of the Division of Range Research in the Intermountain Forest and Range Experimental Station.

In 1966 I accepted a position with Food and Agriculture Organization of the United Nations as an agricultural officer for range management in Sudan. This involved evaluating existing programs and establishing teaching programs for new institutions there.

I have not been able to be active in the Society for Range Management to any great degree since retirement in 1973. However, reading the journal impresses me with the many students who are featured. Most of my work was in close cooperation with universities, so I feel the importance of passing on the information we gather.

One very important part of SRM was the friendships formed. We forged firm friendships that have meant a great deal to us over the years. ◆

SRM Section News

Nevada Section Summer Tour and Meeting, July 9–10, 2004

By Jay Davison

The Nevada Section 2004 summer tour and business meeting was held on July 9–10, 2004. The headquarters for the tour/meeting was on the Hunewill ranch property located above the Bridgeport Valley just west of the Nevada state line. The campsite was along Buckeye Creek in a beautiful meadow at about 7,000 feet of elevation. The Hunewill ranch is a working cattle ranch and very successful guest ranch that was established in 1861. The owners of the ranch graciously donated the camping fees they normally charge groups to the Nevada Section.

The tour was very successful with over 40 individuals attending. This was the largest turnout for a summer tour that our section has experienced for several years. The group toured the Rosaschi ranch, which is located on the east fork of the Walker River in Lyon County near the California line.

The US Forest Service acquired the ranch in 1995 and is in the process of developing a management plan to guide long-term management. The property included a 5-mile segment of the East Walker River renowned as a blue-ribbon brown trout fishery that was previously open only to those who paid a trespass fee to fish. The acquisition conveyed decreed stream water rights and reservoir storage rights tied to the irrigation of approximately 700 acres. A significant system of ditches transported water from the East Walker and a small tributary to irrigate floodplain pastures and cultivated uplands. Nonirrigated uplands were dominated by sagebrush. Forest service management of the ranch for the first 7 years was custodial in nature, and volunteer conservation groups assisted them (Fig. 1). In 2003, the Forest Service completed a NEPA planning process that addressed habitat restoration and public use objectives. The selected alternative included actions to restore native upland vegetation and floodplain wetlands. Irrigation was a primary tool designed to accomplish the restoration. Livestock grazing was retained as a potential vegetation management tool but deferred until vegetation reached "a high similarity to potential natural communities." The Forest Service then began to implement some of the selected alternatives, such as reseeding with native species, regular irrigation of floodplain meadows, and partnering with the US Fish and Wildlife Service to develop a floodplain restoration plan (Fig. 2).

Bridgeport District Ranger Kathleen Lucich welcomed the group, provided the foregoing information, and led a discussion concerning the Forest Service's experiences since acquiring the ranch. She asked the section members present for input and assistance in developing and implementing the long-term plan. Several ideas were discussed during the morning session, which concluded with a bag lunch on a neighboring ranch. The afternoon session included a tour of the neighboring ranch that is still privately owned. Section members compared and contrasted the different management schemes before returning to the headquarters for dinner and drinks.

Figure 1. A decaying ranch house on the US Forest Service Rosaschi ranch located on the east fork of the Walker River in Lyon County, Nevada.

The attendees were treated to a superb dinner of barbecued tri-tip and chicken with all the fixings. Members Barry Perryman, Gary McCuin, and his wife Kay were responsible for the cooking, and we couldn't have had a better meal at any of the finest casinos in Nevada. After dinner, nearly all the members and their families attended a concert featuring cowboy music great Don Edwards, national fiddle-playing champion Randy Pollack, and our own past president John McLain. The concert was held in the beautiful Bridgeport valley on property owned by section member Bennie Romero. Nearly 250 people turned out for the concert. Don Henderson and his wife will remember it well, as he had not 1 but 2 flat tires on the way back to the campsite at midnight.

Saturday morning started with a hearty breakfast and strong coffee. President of the Nevada Section, Angela

Figure 2. Nevada rancher Agee Smith discusses management options from a rancher's perspective on the Nevada Section, SRM, 2005 summer tour.

Mushrush, chaired the business meeting. In case anyone thought the meeting was all fun and games, I've included the major business topics we completed here.

The Nevada Section is doing very well in membership with 26 new members since our winter meeting, and we only lost 4 members during the same time period. The news is especially good, as many of the new members are students, and without their participation, the Society will fade into an old memory.

The members had a long discussion concerning our awards program in Nevada. A motion was made, seconded, and approved to have the Nevada Section join with other groups, such as the Bureau of Land Management, the Cattleman's Association, and so on in recognizing individuals for excellent land stewardship activities. We also voted to establish 3 awards per year. The first would be for sustained achievement in rangeland management and the second for rangeland professional of the year and rangeland producer of the year.

Another important discussion was about the Nevada Section supporting speech contestants and the new Nevada student chapter plant team's attendance at the annual meeting. It was decided to provide economic support in an amount not exceeding $1,000 for travel by competing students to the annual meeting.

The members in attendance voted to support the participation of interested section members on a Rosaschi ranch working group. The group will provide guidance to the Forest Service. Other recommendations included asking NRCS personnel to participate and using selected SRM members as a technical review committee for proposed recommendations coming from the working group.

The membership present voted to contribute one-third of the income generated by the winter meeting to the Parent Society in support of the Washington, DC, office. The consensus was that the presence of an SRM representative was important for issues related to rangelands and that we should receive information on specific activities related to this position from the parent society.

The location of the Nevada Section winter meeting will be Las Vegas. The meetings will include a tour of reclamation efforts on the Nevada Test site.

Planning for the 2007 meeting in Reno has started. Major committee chairs have been named. The national headquarters staff is assisting greatly in the effort and Nevada Section members are looking forward to another record-setting meeting.

Author is Northeast/Central Area Plant and Soils Specialist, University of Nevada Cooperative Extension, 111 Sheckler Road, Fallon, NV 89406.

HIGHLIGHTS

Rangeland Ecology & Management, January 2005

Invited Synthesis Paper: State-and-Transition Models, Thresholds, and Rangeland Health: A Synthesis of Ecological Concepts and Perspectives

D.D. Briske, S.D. Fuhlendorf, and F.E. Smeins

The ecological concepts that underpin the development of state-and-transition models, thresholds, and rangeland health are reviewed and synthesized. The multiple-stable-state concept made these alternative evaluation procedures possible by hypothesizing that multiple stable plant communities may potentially occupy individual ecological sites. State-and-transition models can accommodate the occurrence of multiple stable communities, as well as continuous, reversible vegetation dynamics associated with the traditional range model. Rangeland health and state-and-transition models have not been integrated into a single framework because they rely on unique criteria for categorizing thresholds separating multiple stable states.

Interactive Effects of Drought and Grazing on Northern Great Plains Rangelands

R.K. Heitschmidt, K.D. Klement, and M.R. Haferkamp

Research addressed the interactive effects of spring drought and grazing during and after drought on rangeland productivity. The study involved using an automated rainout shelter to create severe drought situations from April 1 to July 1 during both 1998 and 1999 with and without periodic grazing during the drought years and the 1st post-drought recovery year (2000). Results showed that spring drought reduced total annual herbage production by 20%–40%, largely by reducing cool-season grass production. Study findings, in concert with previous findings, emphasize dependence of the region on spring precipitation and potential risks associated with applying grazing strategies whose success is dependent upon summer rather than spring precipitation.

Shrub Effects on Carbon Dioxide and Water Vapor Fluxes Over Grasslands

A.B. Frank and J.F. Karn

The effect of shrub invasion on CO_2 fluxes in northern Great Plains grasslands is not known. The Bowen ratio/energy balance technique was used to determine CO_2 and water vapor fluxes over a grazed mixed-grass prairie (prairie site) and a mixed-grass prairie that has extensive invasion of shrubs (shrub prairie site). Total growing season CO_2 fluxes were similar in prairie and shrub prairie sites, averaging about 350 g CO_2 m^{-2} (positive flux is CO_2 uptake), but the presence of shrubs altered the seasonal pattern of fluxes. These results suggest that shrub invasion on northern Great Plains grasslands does not reduce the potential of grasslands to sequester atmospheric CO_2.

Soil CO_2 Efflux Responses to Soil Loss on Two Rangeland Ecosystems

Mark S. Thorne, M. J. Trlica, Wayne C. Leininger, R. Dennis Child, and Donald A. Klein

How accelerated rates of soil loss affect the balance of carbon (C) in western rangelands, where rates of C accumulation without disturbance are relatively slow, is not well understood. The purpose of this study was to determine the effects of soil loss on total, bare soil, and plant respiration rates at short-grass prairie and sagebrush steppe sites. Increased total respiration rates observed on the short-grass prairie resulted primarily from increased plant respiration rather than from changes in bare soil respiration. Thus, changes in plant respiration following disturbance may be more important to total soil CO_2 efflux than soil flora and faunal respiration, which appeared to be more resistant to disturbance.

Emergence of Dallisgrass as Affected by Soil Water Availability

P.S. Cornaglia, G.E. Schrauf, M. Nardi, and V.A. Deregibus

It is very difficult to incorporate Dallisgrass into humid temperate grasslands through interseeding. We studied the effects of water availability on seed germination and seedling growth under controlled conditions to determine which step of the establishment process was most affected. This species showed high sensitivity to water stress during germination and early emergence. High emergence was obtained from the daily irrigation treatment. High availability of water, combined with the high temperatures required for breaking seed dormancy, occur infrequently, explaining the difficulty of achieving successful establishment of Dallisgrass. Water availability during these processes is a critical factor for survival of this species.

Clipping Frequency Affects Canopy Volume and Biomass Production in Planeleaf Willow (*Salix planifolia* var. *planifolia* Prush)

Mark S. Thorne, Paul J. Meiman, Quentin D. Skinner, Michael A. Smith, and Jerrold L. Dodd

Little is understood about how the frequency of browsing affects aboveground and belowground willow production. The objectives of this study were to determine how the frequency of simulated browsing events in a controlled environment affected 1) the aboveground, belowground, and total biomass production, and 2) the canopy volume of planeleaf willow (*Salix planifolia* var. *planifolia* Prush) plants. Results suggested that frequency of clipping alone did not explain differences in aboveground and belowground willow production. Instead, willow production was influenced by an accumulation of specific combinations of seasonal clipping events that were dependent on the clipping history of the plants. These results have important management implications that should be considered when grazing riparian areas.

Vizcacha´s Influence on Vegetation and Soil in a Wetland of Argentina

Santiago M. Arias, Rubén D. Quintana, and Marcela Cagnoni

The vizcacha's activity strongly affects its habitat by grazing, trampling, and soil removal. To evaluate these effects, we carried out a vegetation and soil survey. Our results show that vizcachas diminished plant cover and grass biomass in their grazing areas, and that a few characteristic plant species dominated the disturbed areas. These areas also had higher cation exchange capacity and electric conductivity, and higher clay and sodium contents than did undisturbed areas. The rodents' activity introduces a recurrent disturbance factor to the landscape, the outcome of which is the alteration of both the composition and structure of the botanical communities, and of some soil properties.

Nutritional Value of Guajillo as a Component of Male White-Tailed Deer Diets

Tyler A. Campbell and David G. Hewitt

To examine the nutritional value of guajillo to white-tailed deer more thoroughly, we present a comparison of mixed diets of 0%, 25%, 50%, and 75% guajillo in male white-tailed deer. Four in vivo metabolism trials were completed with each diet. Nitrogen requirements for body growth and antler development were met by diets containing < 60% guajillo, whereas energy requirements for maintenance and antler growth were met with diets containing < 20% guajillo. The primary function of guajillo may be to facilitate maintenance of adult deer, which have fewer obligatory productive processes than young deer, during periods of drought.

Wyoming Big Sagebrush Recovery and Understory Response With Tebuthiuron Control

K.C. McDaniel, L.A. Torell, and C.G. Ochoa

Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle and Young) recovery following chemical control with tebuthiuron was investigated over a 20-year period at 8 study sites in northwestern New Mexico. The herbicide treatment was found to be long lasting with a substantial response of the herbaceous understudy. Treatment life is projected to exceed 35 years for 6 of 8 study sites. Annual average grass yield increased about 3 times on most treated areas.

Economics and Optimal Frequency of Wyoming Big Sagebrush Control With Tebuthiuron

L.A. Torell, K.C. McDaniel, and C.G. Ochoa

The economics and optimal frequency of Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle and Young) control using tebuthiuron were evaluated based on the expected rate of recovery following herbicide application, and how the brush overstory suppresses grass yield. This long-lasting control treatment was found to be an economical alternative for landowners participating in available cost-share programs. Tebuthiuron treatments were generally projected to last 35 or more years, but a 2nd brush control treatment should optimally be implemented before herbage production is fully depleted by the recovering sagebrush. The economic threshold abundance of big sagebrush was found to vary from a canopy cover of 6% to 14%, depending on site productivity and assigned forage value.

Mauto (*Lysiloma divaricatum*, Fabaceae) Allometry as an Indicator of Cattle Grazing Pressure in a Tropical Dry Forest in Northwestern Mexico

A. Breceda, V. Ortiz, and R. Scrosati

Determining reliable, quick indicators of cattle grazing pressure is important in rangeland ecology and management. We compared plant height, canopy cover, and basal trunk diameter of mauto (*Lysiloma divaricatum*), an arborescent legume, from grazed and ungrazed areas in a tropical dry forest in northwestern Mexico. The height–diameter and cover–diameter allometric relationships differed significantly between the 2 areas, with basal diameter increasing faster per unit increase in height or cover in the grazed area than in the ungrazed area. Therefore, mauto allometry might be used to quickly assess cattle grazing pressure in tropical dry forests.

An Evaluation of Arizona Cooperative Extension's Rangeland Monitoring Program

Maria E. Fernandez-Gimenez, George Ruyle, and Susan Jorstad McClaran

Arizona Cooperative Extension has been teaching rangeland monitoring for many years, but had no information on whether this program influenced rancher or agency monitoring practices. To address this gap, we conducted a program evaluation using focus groups and a mail survey. We found that Extension contact is associated with monitoring adoption and with implementation of other beneficial management practices, and that in many cases monitoring by permittees improved agency–permittee relationships. Rangeland monitoring is a social as well as a technical process, and Cooperative Extension plays an important role in both the technical and social dimensions of monitoring.◆

Jeff Mosley

Browsing the Literature

This section reviews new publications available about the art and science of rangeland management. Personal copies of these publications can be obtained by contacting the respective publishers or senior authors (addresses shown in parentheses). Suggestions are welcomed and encouraged for items to include in future issues of *Browsing the Literature*.

Animal Ecology

Desert mule deer survival in southwest Texas. R.K. Lawrence, S. Demarais, R.A. Relyea, S.P. Haskell, W.B. Ballard, and T.L. Clark. 2004. *Journal of Wildlife Management* 68:561–569. (Environmental Systems Research Institute, 317 Ruby Ave., Redlands, CA 92374). Effects of drought decreased pregnancy rates for mule deer, especially for young and old females ($\leq$ 1.5 years old and $\geq$ 6.5 years old, respectively).

Determination of critical habitat for the endangered Nelson's bighorn sheep in southern California. J.C. Turner, C.L. Douglas, C.R. Hallam, P.R. Krausman, and R.R. Ramey. 2004. *Wildlife Society Bulletin* 32:427–448. (Dept. of Biological Sci., Sam Houston State Univ., Huntsville, TX 77340). Distances within 1.9 miles of perennial water appeared to constitute prime habitat for bighorn sheep.

Habitat use and nest site selection by nesting lesser prairie-chickens in southeastern New Mexico. K. Johnson, B.H. Smith, G. Sadoti, T.B. Neville, and P. Neville. 2004. *Southwestern Naturalist* 49:334–343. (Dept. of Biology, Univ. of New Mexico, Albuquerque, NM 87131). Results suggest that herbicide treatment to control sand shinnery oak might adversely impact nesting lesser prairie-chickens.

Height to withers and abdominal circumference effects on diets of grazing goats. A. Mellado, A. Rodriguez, J.A. Villarreal, and R. Lopez. 2004. *Applied Animal Behaviour Science* 88:263–274. (Dept. of Nutrition and Foods, Univ. de Autonoma Agraria Antonio Narro, Saltillo 25315, Mexico). Shrubs and forbs were preferred by goats in northern Mexico. Smaller goats ate more grass than large goats did and, during the rainy season, taller goats ate more shrubs than did shorter goats.

Livestock grazing effects on ant communities in the eastern Mojave Desert, USA. M.S. Nash, D.E. Bradford, S.E. Franson, A.C. Neale, W.G. Whitford, and D.T. Heggem. 2004. *Ecological Indicators* 4:199–213. (US EPA, PO Box 93478, Las Vegas, NV 89193). Ant abundance was positively related to the amount of litter, or mulch, on the ground surface.

Neonatal mule deer fawn survival in west-central Colorado. T.M. Pojar and D.C. Bowden. 2004. *Journal of Wildlife Management* 68:550–560. (Colorado Division of Wildlife, PO Box 1114, Kremmling, CO 80459). Declines in mule deer populations were not caused by poor survival of fawns, leading the authors to hypothesize that fetus mortality during late pregnancy or mortality of fawns at birth may be to blame.

Grazing Management

Conditioning cattle to graze broom snakeweed (*Gutierrezia sarothrae*). M.H. Ralphs and R.D. Wiedmeier. 2004. *Journal of Animal Science* 82:3100–3106. (USDA-ARS, Poisonous Plant Research Lab, 1150 East 1400 North, Logan, UT 84341). "Cattle can be forced to graze snakeweed in a short-duration, high-intensity grazing strategy."

Nonstructural carbohydrate supplementation of yearling heifers and range beef cows. J.G.P. Bowman, B.F. Sowell, L.M.M. Surber, and T.K. Daniels. 2004. *Journal of Animal Science* 82:2724–2733. (Dept. of Animal and Range Sci., Montana State Univ., Bozeman, MT 59717). Energy supplementation in winter decreased forage digestion and intake when cows grazed rangeland forage that contained adequate amounts of protein relative to energy.

Hydrology/Riparian

Dynamics of evapotranspiration in semiarid grassland and shrubland ecosystems during the summer monsoon season, central New Mexico. S.A. Kurc and E.E. Small. 2004. *Water Resources Research* 40(9): W09305 (Dept. of Geological Sci., Univ. of Colorado, Boulder, CO 80309). On black grama grassland and creosotebush shrubland, infiltration following rainfall events usually wets only the top 4 inches of soil.

Historical evidence of riparian forests in the Great Plains and how that knowledge can aid with restoration and management. E. West and G. Ruark. 2004. *Journal of Soil and Water Conservation* 59:104A–110A. (Dept. of History, Univ. of Arkansas, Fayetteville, AR 72701). Until the mid 1800s, riparian areas along major rivers and their tributaries in the Great Plains were dominated by trees.

Management Planning

Tragedy averted: the promise of collaboration. T.A. Bryan. 2004. *Society and Natural Resources* 17:881–896. (2242 15th St., Boulder, CO 80302). This article explores how natural resource decision-making processes can be structured and managed to create a culture of shared ownership.

Plant Ecology

Effects of temporal variability on rare plant persistence in annual systems. J.M. Levine and M. Rees. 2004. *American Naturalist* 164:350–363. (Dept. of Ecology, Evolution, and Marine Biology, Univ. of California, Santa Barbara, CA 93106). Yearly fluctuations in weather may be essential for forbs to persist in California annual grasslands. Competition from grass increased during consecutive years of favorable precipitation.

Object-oriented image analysis for mapping shrub encroachment from 1937 to 2003 in southern New Mexico. A.S. Laliberte, A. Rango, K.M. Havstad, J.F. Paris, R.F. Beck, R. McNeely, and A.L. Gonzalez. 2004. *Remote Sensing of Environment* 93:198–210. (USDA-ARS, Jornada Experimental Range, 2995 Knox St., Las Cruces, NM 88003). Shrub cover increased from 0.9% in 1937 to 13.1% in 2003, while grass cover declined from 18.5% to 1.9%. Vegetation changes reflected changes in precipitation patterns, in particular the effects of the 1951–1956 drought.

Potential effects of climate change on the temperate zones of North and South America. W.K. Lauenroth, H.E. Epstein, J.M. Paruelo, I.C. Burke, M.R. Aguiar, and O.E. Sala. 2004. *Revista Chilena de Historia Natural* 77:439–453. (Dept. of Forest, Rangeland, and Watershed Stewardship, Colorado State Univ., Fort Collins, CO 80523). Concludes that any increase in temperature caused by climate change will cause the driest portions of both continents to expand. In North America, deserts will expand at the expense of grasslands, and grasslands will expand at the expense of forests.

The status and management of exotic and invasive species in national wildlife refuge wilderness areas. D.J. Tempel, A.B. Gilimburg, and V. Wright. 2004. *Natural Areas Journal* 24:300–306. (V. Wright, Aldo Leopold Wilderness Research Institute, PO Box 8089, Missoula, MT 59807). A survey revealed that invasive plants were considered a major problem in 26% of the wilderness areas surveyed in the lower 48 states. Respondents commonly cited a lack of staff or funding as barriers to better monitoring and management.

Reclamation/Restoration

2,4-D and *Phoma herbarum* to control dandelion (*Taraxacum officinale*). P.J. Schnick and G.J. Boland. 2004. *Weed Science* 52:808–814. (Dept. of Environmental Biology, Univ. of Guelph, Guelph, ON N1G 2W1, Canada). When a fungal pathogen, *Phoma herbarum*, was combined with 2,4-D herbicide, there was a synergistic effect that resulted in much greater control of dandelion.

A place for alien species in ecosystem restoration. J.J. Ewel and F.E. Putz. 2004. *Frontiers in Ecology and the Environment* 2:354–360. (Pacific Southwest Research Station, 1151 Punchbowl St., Suite 323, Honolulu, HI 96813). This viewpoint article discusses why blanket condemnation of nonnative species in restoration efforts is counterproductive.

Brush management: Past, present, future. W.T. Hamilton, A. McGinty, D.N. Ueckert, C.W. Hanselka, and M.R. Lee (eds.). 2004. Texas A&M Univ. Press, Texas A&M Univ., College Station, TX 77843. 296p. US$50 cloth, US$26 paperback + $5 shipping. ISBN: 1585443557 (cloth) or 1585443573 (paperback). In this new book, leading experts explain the state-of-the-art in brush management practices for Texas rangelands.

Herbage yield and crude protein concentration of rangeland and pasture following hog manure application in

southeastern Alberta. L.J. Blonski, E.W. Bork, and P.V. Blenis. 2004. *Canadian Journal of Plant Science* 84:773–783. (E. Bork, Dept. of Agriculture, Food, and Nutrition Sci., Univ. of Alberta, Edmonton AB T6G 2P5, Canada). Even in drought, nutritive quality of native rangeland was improved by application of liquid hog manure.

Natural product herbicides for control of annual vegetation along roadsides. S.L. Young. 2004. *Weed Technology* 18:580–587. (Univ. of California Hopland Research and Extension Center, Hopland, CA 95449). Natural product herbicides (pine oil, acetic acid, and plant essentials) were less effective and much more expensive than glyphosate herbicide.

Postfire seeding for erosion control: Effectiveness and impacts on native plant communities. J.L. Beyers. 2004. *Conservation Biology* 18:947–956. (USDA-ARS, 4955 Canyon Crest Dr., Riverside, CA 92557). Reviews the limited data available about the effectiveness of broadcast seeding after wildfire.

Socioeconomics

Increasing off-site water yield and grassland bird habitat in Texas through brush treatment practices. K.L. Olenick, R.N. Wilkins, and J.R. Conner. 2004. *Ecological Economics* 49:469–484. (Plateau Land and Wildlife Management, PO Box 1251, Dripping Springs, TX 78620). Created a methodology for prioritizing which areas should receive public cost-share money for brush treatment in central Texas.

Liability, incentives, and prescribed fire for ecosystem management. J. Yoder, D. Engle, and S. Fuhlendorf. 2004. *Frontiers in Ecology and the Environment* 2:361–366. (School of Economic Sciences, Washington State Univ., Pullman, WA 99164). States in the southeastern US have innovative laws that address liability concerns about prescribed burning. These laws provide examples of how other states and provinces could develop policies that would encourage wider use of prescribed fire as a natural resource management tool.

Soils

Effects of the invasive forb *Centaurea maculosa* on grassland carbon and nitrogen pools in Montana, USA. P.B. Hook, B.E. Olson, and J.M. Wraith. 2004. *Ecosystems* 7:686–694. (Dept. of Land Resources and Environmental Sci., Montana State Univ., Bozeman, MT 59717). Spotted knapweed generally did not alter amounts of soil carbon or soil nitrogen in native grasslands.

Temporal and spatial patterns of soil water following wildfire-induced changes in plant communities in the Great Basin in Nevada, USA. D. Obrist, D. Yakir, and J.A. Arnone. 2004. *Plant and Soil* 262:1–12. (Univ. of Basel, Bernoullistr 30, CH-4056 Basel, Switzerland). Compared with sagebrush-dominated sites, cheatgrass sites have lower soil water recharge in winter, leading to less plant-available soil water in the root zone of perennial grasses and sagebrush, thus impeding their re-establishment.

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The Recipe Corner

Editor's Note: *There are many "family" recipes that are passed from generation to generation and never seen by outsiders. Many of these recipes would be enjoyed by others. This column is being established to share some of these recipes. As a starter, we are reprinting with the permission of the Society for Range Management a recipe that appeared in the* Trail Boss's Cowboy Cookbook, *March 1988, from Mrs Arthur D. Miles, Lazy AM Ranch, Bozeman, Montana.*

Sourdough Pancakes

To begin with, you've gotta have "starter," which is a batch of flour and yeast that you can keep for years and years (scary when you think about it sitting there in your refrigerator).

Starter

½ package active dry yeast
2½ cups lukewarm water
1 tablespoon sugar
2 cups flour

Soften yeast in ½ cup water. Add rest of ingredients and mix well. Let stand in a covered bowl or crock (not metal) for 3 days at room temperature (76–80°F). Stir down daily. Refrigerate after 3 days. Now you are ready to make pancakes!

Pancakes

1 cup starter*
2 cups lukewarm water
about 2½ cups flour
1 tablespoon sugar
2 tablespoons sugar
1 egg
2 tablespoons cooking oil
1 teaspoon baking soda
¼ cup evaporated milk or cream
*Refrigerate the remaining starter.

Evening: Put starter in a large bowl. Add water, flour, and 1 tablespoon sugar. Mix well. (It will be thick and lumpy.) Cover and leave in a warm place overnight.

Next morning: Take 1 or 2 cups of batter and put back in starter bowl. Then to remaining batter add egg, cooking oil, and milk. Add salt, baking soda, and 2 tablespoons sugar. Mix into batter gently. This causes foaming and a rising action. Let stand a few minutes and then fry on hot greased griddle. Add a little milk if too thick. Yum—enjoy.

Background: Our ranch is between Livingston and Bozeman, Montana (60 miles from Yellowstone National Park). There was a stopover place (saloon/post office) here where fresh horses were put on the stagecoach before going over Bozeman Pass. You can bet lots of sourdough pancakes were served. We still live in the original house built in 1870. ◆

BOOK REVIEW

The Hanford Reach: A Land of Contrasts. By Susan Zwinger. 2004. The University of Arizona Press, Tucson. 79 p. US$13.95 paper. ISBN 0-8165-2376-2.

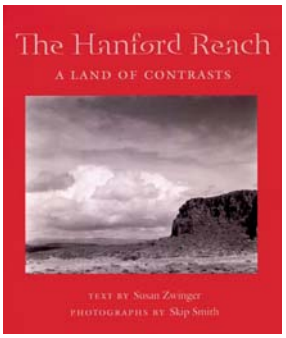
As I write this review I am watching the arrival of football revelers from all over the state of Washington for the annual "Apple Cup" game between the Washington State University Cougars and the University of Washington Huskies. To get here to Pullman, many of those "West Side" fans will drive across the rain-shadow desert of eastern Washington and through the northern edge of the Hanford Reach, a part of the cold desert around Hanford, Washington, that is adjacent to the last free-flowing section of the Columbia River. I have heard many describe the drive, in a number of different variations, as uninspiring. After the game, Thanksgiving vacation traditionally begins, and most of the fraternity guys can't wait to get to Seattle or elsewhere on the West Side. They don't mind driving in the dark partly because, most would assert, it is a mind-numbingly dull drive even in the daytime.

This same desert area, often maligned by travelers who want *more*, is the subject of Dr Susan Zwinger's short new book, *The Hanford Reach*, which briefly covers the history and emotionally examines the ambiance of the "industrial desert" of eastern Washington. Dr Zwinger is a transplant from the Southwest, and a former assistant professor, museum curator, and naturalist ranger turned writer now residing on a green, picturesque island off the Washington coast.

The Hanford Reach is an attractive little book, 6 × 7 inches dimensionally, and is part of a series of what are essentially long essays on selected locations throughout the West that is being published by the University of Arizona Press. The book's impressive cover photograph is of a mesa in the Hanford desert. About 20 black-and-white photographs are interspersed with the text. The book includes a short bibliography.

The book has distinct chapters that suggest more topical organization than actually exists. It is loosely structured topically, and does not convey a strong sense of chronological structure either, although one does exist. The book's history, which is romanticized in presentation and cursory in content, is effective prose, at least until it is blended with the author's effusive emotions and artistic stretches to produce a kind of atomic desert dreamscape.

But fine art is rarely rooted in sentiment, and the sentimental writing in parts of *The Hanford Reach,* like the overblown spectacle surrounding the Apple Cup, is deliriously over the top. On this football weekend, I cannot help but smile at the contrast between the enraptured metaphoric prose of Dr Zwinger as investigative journalist on extended desert holiday, and the "who cares" attitude of so many students here who dismiss or disdain the shrub-steppe atomic desert. Such stark contrast, (about "a land of contrasts" no less*),* between the sentimental and the utterly disinterested is inherently amusing. At one point the author notes, "Picking up some thirty empty beer bottles marring the sand, I drive south through the ten-million-year-old Elephant Mountain Flow, which tilts steeply and mimics pachyderm skin." Apparently some of our reveling students had preceded her there. She later writes, "I slept near Wallula on a desert creek last night and awakened this morning to the doves, wrens, quails, orioles, meadowlarks, ducks, and a snipe's winnowing wings. Someone is chortling down in the reeds like a turkey baster being squeezed under water." It is probably some fraternity types, I muse, hazing a freshman who is being squeezed under water. Or how about: "Suddenly a spiral trill of familiar hosannas. I so miss the ultimate songster of the desert Southwest, but here he is—a Washingtonian cactus wren! Enjoying the cold, I remain a long time writing. Soon the sun will sear the Grande Ronde, as jagged as giant saw teeth. I kneel, examining the frilled can-can skirts of evening primroses. Wind whipped grasses etch arches in the sand. Steep-angled shadows cast each plant with an elongated purple copy."



That's rich, I'll say. Such artistic self-indulgence could make entertaining reading aloud on National Public Radio, if one could find the ideal reader to animate it. To play it straight, Greer Garson would be a natural choice to give it a good chance, were she still living. But

the brilliant Mel Blanc, who unfortunately is also deceased, and has taken his over-the-top, web-footed persona with him, would have had an easier time with it.

The black-and-white photography in *The Hanford Reach,* by Skip Smith, another professor, is, with several exceptions, nearly as artistically stretched as the prose. The excellent cover photo and one other fine interior photo of twin basalt towers should have reminded the photographer to let the harshly magnificent reality of the place coolly speak for itself. Instead, many of the other photos show an unsatisfied quest for abstract art.

If you have not already discerned it from the preceding excerpts, Dr Zwinger's prose is in many places an uneasy mix of retro-modern imagery, dubious metaphors, and dreamy metaphysics, punctuated occasionally by incongruous 1960s-style earthiness, all crafted and polished from an aesthetically elite island perch that fosters full sentimental savoring. So by the time the author ends with, "Alas, with the Hanford Reach so new and gleaming, I would like to play at being Athena just a little bit longer," you'll be grateful for her mortality. The author's perspective is an informed one, but much of the writing is too sentimental, too self-absorbed, and too self-conscious. The self-conscious reach for literary art is conspicuous. The author, like so many modern artist-types, acknowledges her ever-present search for the genuine and the authentic, even as she undermines its authenticity by artistically romanticizing and civilizing it. She embraces the Hanford Reach as if to hug the authentic life out of it, forgets the power of understatement, and seems euphorically unaware that sentimental prose might not do artistic justice to the minimalist landscape and its contorted history. This inherent incompatibility of language and subject helps reveal the prose as decidedly derivative; it feels forced, less natural even than the industrialized desert landscape the author describes.

"A hundred and thirteen degrees is not heat at all but a body of viscous polyethylene that coats one down into the lungs. The plants, which were so colorful and fruitful just two months ago, are dry, dormant rattles. Livestock are sweltering, miserable lumps. Birds silent. The heat is not heat but a sticky drapery, which hangs over me, over mouth and nose so I cannot breathe. I stay out in it purposefully, drink electrolytes and salts, but no food since morning. I grow weak, so dutifully force bits of tuna to my tongue and chew as if through gum erasers. Heat is not a temperature but a physical churning. Forty minutes later I upchuck in the bitterbrush. In heat, logical thought does not work."

I think I know how she felt. And any of those post-game revelers from the Cougar-Husky game who might read *The Hanford Reach* will be relieved by the realization that, although the drive through the atomic desert of eastern Washington may be as dull as ever, they'll find plenty of bitterbrush along the way.

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BOOK REVIEW

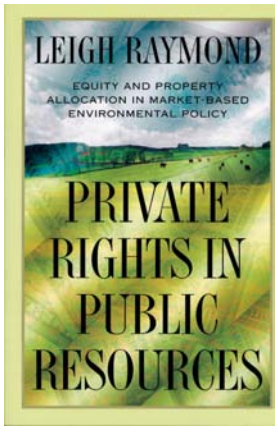
Private Rights in Public Resources: Equity and Property Allocation in Market-Based Environmental Policy. By Leigh Raymond. 2003. Resources for the Future Press, Washington DC. 253 p. US$55.00 hardbound, US$21.95 paperback. ISBN 1-891853-69-4 (hardcover), 1-891853-68-6 (paper).

The author of this book, a professor of political science at Purdue University, contends that previous analyses of market-based environmental policies have focused on efficiency instead of equity and distributional issues. The book fills this gap by demonstrating how well-accepted principles of fairness and distributive justice have guided politicians in allocating private rights to public resources newly created by market-based programs. The sources of these principles are the classic theories of property espoused by Hume, Locke, Cohen, and Proudhon. Empirical attention is focused on programs regulating sulfur dioxide and greenhouse-gas emissions, and on public lands grazing.

Chapter 1 sets the stage by defining key terms in market-based policy (eg, "licensed property"), and by considering and rejecting common objections to considering equity issues in analysis. Chapter 2 constructs the framework of property theories that are put to use in the remainder of the book. The framework includes the "possessory view" of Hume (property is a protection against theft and an aid to voluntary exchange), the "intrinsic view" of Locke (property is a natural right that exists independently of government), the "instrumental view" of Cohen (property is a human invention that can be adapted to meet evolving social goals), and the "egalitarian view" of Proudhon (property must be allocated and redistributed periodically to ensure distributive equality). Chapters 3, 4, and 5 apply the property framework to investigate initial rights allocations under the Clean Air Act Amendments of 1990, the Taylor Grazing Act, and international policies regulating greenhouse-gas emissions. Chapter 6 summarizes the policy implications of applying the property framework to the empirical cases.

In my opinion, this is an excellent book for classroom use and professional development. The author is a gifted writer who explains concepts clearly, concisely, and in an engaging manner. I was especially impressed by the deft presentation of property theories in Chapter 2. The figures help the reader compare the various theories according to key characteristics: the security of property rights, the prepolitical or political justification for ownership, and the emphasis placed on individual versus collective goals. The ensuing chapters, applying the property framework to existing market-based policy, demonstrate the valuable insights into policy formulation gained by using this approach. By Chapter 6, one is persuaded by the author's conclusion that equity norms do indeed help shape political behavior.

The chapter applying the property framework to the Taylor Grazing Act exemplifies the importance of equity issues in formulating policy. The author effectively frames the battle over whether initial grazing rights would be granted on the basis of prior use or commensurate property as a conflict between the intrinsic view of Locke and the instrumental view of Cohen. The intrinsic view supports prior use as the equitable way to protect the rights of individuals previously using the public range. The instrumental view supports granting rights to individuals with commensurate property as a means of promoting the social benefits of stable rural western communities. Policy makers found an equitable resolution to the conflict by initially granting grazing preferences on the basis of priority—giving prior users the opportunity to acquire commensurate property—before a shift to commensurability was put in place. In the other case studies, the author demonstrates how policy makers fashioned similarly equitable accommodations of conflicting property principles in different historical and ecological settings.



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