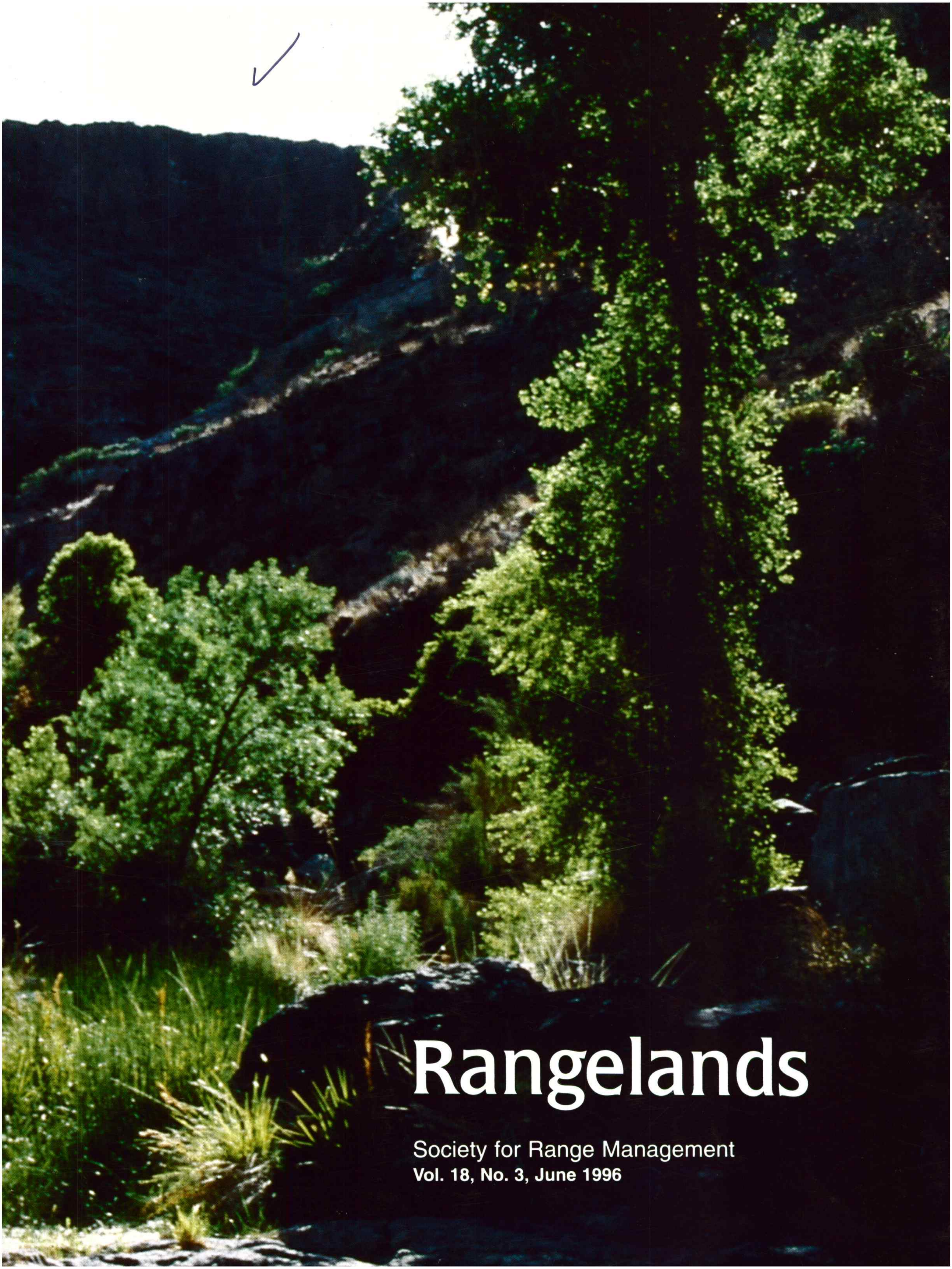

# Rangelands

Society for Range Management
**Vol. 18, No. 3, June 1996**

# Rangelands

## FEATURE ARTICLES



## DEPARTMENTS



## COVER PHOTO

Cottonwoods growing along Arroyo Primero in Big Bend Ranch State Park, a 265,000 acre wilderness managed by the Texas Parks and Wildlife Department. Photo by Matt Wagner.

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*—to properly take care of the basic rangeland resources of soil, plants and water;*

*—to develop an understanding of range ecosystems and of the principles applicable to the management of range resources;*

*—to assist all who work with range resources to keep abreast of new findings and techniques in the science and art of range management;*

*—to improve the effectiveness of range management or obtain from range resources the products and values necessary for man's welfare;*

*—to create a public appreciation of the economic and social benefits to be obtained from the range environment;*

*—to promote professional development of its members.*

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# Executive Vice-President's Report

I previously shared with you information from a meeting on invasive weeds that came out of a conference held in Denver in September of 1995. A second meeting on the same subject was held in Ft. Lauderdale, Florida later in 1995. Issues arising from those two meetings were further discussed through facilitated meetings organized by the Western Weed Coordinating Committee (WWCC) at their regular meeting in Albuquerque, New Mexico in March, to look at developing a national strategy.

The Society for Range Management, in conjunction with the WWCC meeting, joined with private industry, state and federal government, commodity, resource and other nonprofit organizations in a facilitated meeting to determine if it was possible to develop a common vision, mission and objectives for managing invasive weeds. The number of organizations invited to participate (about 20) was limited by available resources; that number could easily have doubled based on interest in managing these extremely aggressive plants. The output from that meeting follows.

This group named itself the National Weed Coalition. Their Vision: We are an inclusive, influential, national coalition of organizations whose goal is to minimize the threat from aggressive, invasive plants to all land and water ecosystems. Their mission: The Coalition provides leadership and encourages development of policies, strategies and incentives to manage invasive plants. The Coalition resolves conflict, removes barriers and encourages resource development necessary for effective invasive plant management through the strength of its diverse representation and through sponsoring collaborative forums.

First year priority tasks: 1. recruit partners not yet at the table, 2. promote awareness via newsletters, etc. within each coalition member's organization, 3. collect existing white papers as reference for creating a Coalition white paper and, with these citations, review and sign support, 4. support the Intermountain Noxious Weed Advisory Council's effort to redirect and increase the priority for federal funds going toward invasive weed control. One or more individuals was named to follow through on accomplishing each of these tasks.

Weeds have traditionally been an agricultural problem. The old paradigm goes something like this: weeds compete with agricultural plants and that competition reduces commodity production. Farmers and ranchers have an incentive to control weeds because it increases commodity production; therefore, weeds are an agricultural problem. The paradigm has changed. Invasive plants continue to increase their occupancy of natural areas, highway and railroad right-of-ways, waterways, wildlife refuges, and industrial sites.

Rangeland scientists have studied the problem of invasive plants from a ecological perspective for many years. Dr. James Young, for example, was one of the first that I know about to use the term "invasive plants" and I believe he coined the term "biological suppression" to describe his concepts for ecologically managing these pests. While invasive weeds remain an agricultural problem, they are no longer just an agricultural problem. Many now perceive them as a form of biological pollution whose adverse impact on wildlife and other native organisms is only beginning to be appreciated; however, their impact on rangeland ecosystems has been known for some time. Agriculture and natural resource managers now have many new allies in fighting these pests, but we need to recognize that these new allies bring with them a more complex and diverse set of issues.

I personally believe that it is essential for agriculture to remain active and involved with this coalition. Agriculture's heritage of voluntary programs accomplished through research, education and technology transfer continues to be one of the best models ever developed. And I would argue that it is the very best for addressing diverse and widely dispersed problems occuring across the landscape, encompassing both public and private land. Agriculture also needs to do a better job of educating our new allies about the tremendous value of incentives for recruiting private land owners to assist in and thereby become knowledgeable of the program, problems and opportunities.

Among the worst of these invasive weeds and with the current technology available, I cannot visualize control, and can only think in terms of management and containment. To achieve just that on an annual basis will require resources beyond my ability to comprehend and calculate. To achieve a measure of control will require programs akin to the adopt-a-highway program—the model used for highway cleanup: one mile at a time, with thousands of individuals and groups accepting responsibility for their own "mile". Each year, nay each day, of delay increases the problem. One estimate is 14% annually if unchecked (at that rate it would double in 5 years). Weed scientists believe the pests tend to increase exponentially. To have a significant impact will require a level of national resolve similar to that manifested upon our entrance into world war II. Is that possible? Perhaps. Individuals charged with control responsibility frequently describe it as a war. If we don't begin now, then when?—**Bud Rumburg**, SRM, EVP.

# Habitat Restoration—Solving the Puzzle of Wildlife Diversity in Texas

**Matt Wagner and Jenny Pluhar**

Texas is blessed with over 170 million acres of mostly rural countryside. From Chihuahuan Desert to pine forests, over 97% of this acreage is managed by private landowners. Private land stewardship insures the perpetuation of wildlife habitat through sustainable agricultural and wildlife management practices.

As a public land steward, the Texas Parks and Wildlife Department (TPWD) has been engaged in habitat restoration on wildlife management areas, state parks, and state natural areas totalling over one million acres. Although management objectives differ among these land areas, quality wildlife habitat is a common goal to meet the needs of folks wishing to hunt, camp, watch wildlife or simply enjoy the outdoors. Consider all that has been learned about creating habitat for game species like white-tailed deer. Opinions from different areas of the state, and even within the same area still vary widely on the issue. How is an agency charged with the management of **all** wildlife going to deal with nongame species which we know relatively little about?

One approach may be to concentrate on restoring what is known to be missing in the habitat puzzle, instead of focusing on the biological aspects of the wildlife themselves. Like a jigsaw puzzle missing a few pieces, changes in wildlife populations today are a reflection of missing habitat pieces lost over time. The general picture is still visible, but a few pieces have been lost. As grasslands are converted to shrublands, forests are converted to pasture, wetlands are drained, exotic species proliferate, and bottomland hardwoods continue to be lost, dramatic changes in wildlife populations have been occurring. The physical structure of habitat reflects the function of that habitat, and what kinds of species will find a home there. As habitat changes, either due to natural factors (flood, drought, fire, etc.) or by the hand of man, so will the wildlife populations that depend on that habitat.

*Bright Leaf is a 200 acre urban natural area in upsale West Austin. Photo by Matt Wagner*

Restoring habitat actually re-creates important missing pieces in the natural system, and may provide refuge for a whole suite of wildlife species not considered previously in management plans for a particular site. Examples of restoration of tallgrass prairie, freshwater marsh, oak savannahs, subtropical thorn woodlands and semiarid grasslands can be seen on TPWD holdings. Land restoration techniques are many, and include prescribed burning, selective herbicide treatments, various mechanical techniques, managed grazing by livestock, and enhancement of natural means like seed dispersal through wind, water and animals.

A term used a lot today is "habitat fragmentation". Habitat fragmentation occurs where discontinuous land use creates irregular patches across the landscape. Today, habitat fragmentation is occurring rapidly in suburban areas as development expands into former farm and ranch operations. Large land holdings are being subdivided. Roads, boundary fences, and utility easements are being constructed.

Fragmentation is not always bad. Row crops were fragmented with permanent grass cover when lands were enrolled in the Conservation Reserve Program. A parking lot can be fragmented with islands of native plants. Habitat fragmentation will continue as long as people need places to live and work. Resource managers are forced to look at restoration as means to mitigate fragmentation, as well as a linking remaining habitats along common corridors such as drainages and fence lines.

The greatest threat to wildlife habitat in Texas is the subdivision of large land holdings into smaller tracts. More than half of the population of Texas is located in six cities: Austin, Dallas, El Paso, Ft. Worth, Houston and San Antonio. As human populations continue to grow, resource managers are forced to develop technologies to restore and maintain habitat fragments in order to support viable wildlife populations. Changes in land use from agriculture-based to suburban development mean additional habitat fragmentation. Under these conditions, corridors or "linear habitats" are extremely important. Fence lines, drainages, and roadways are all potential linear habitats that, when linked together, can form mutual corridors for wildlife traveling between small blocks of habitat.

Consider TPWDs Bright Leaf tract in Austin, Texas. Bright Leaf is about 200 acres of prime live oak-juniper woodland completely surrounded by urban development, a true "island" of habitat. This beautiful piece of property harbors rare plants. Even the endangered Golden-cheeked warbler nests here. Unfortunately, this urban preserve may not meet the needs of

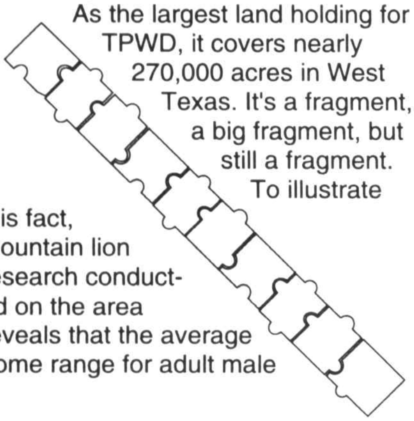
*Chinese tallow threatens large areas of the Upper Texas Coast such as coastal prairie at Peach Point Wildlife Management Area near Houston. Photo by Matt Wagner.*

*Big Bend Ranch State Park in far West Texas is the largest TPWD holding at 270,000 acres. Photo by Matt Wagner.*

those special resources over the long term.

If habitats become fragmented enough, the survival of organisms is threatened. At Bright Leaf, an abundance of exotic landscapes are invading from the surrounding neighborhoods. The invasion of exotic species into native habitats can devastate wildlife populations. Seemingly harmless plants such as Chinese tallow and insects such as the imported fire ant have altered entire ecosystems. The question is: Is there a way to make tracts like Bright Leaf viable ecosystems? Is there a way to maintain the quality of these tracts so that they can sustain wildlife populations into the future?

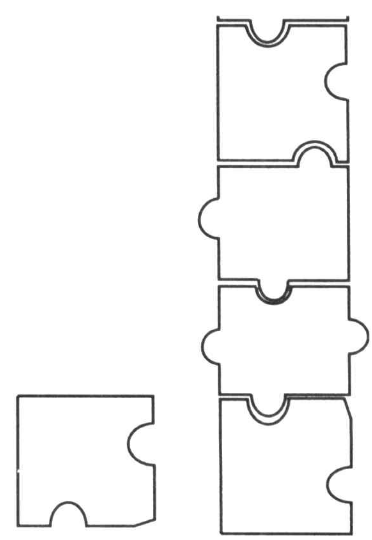
At the other end of the habitat spectrum is Big Bend Ranch State Park. As the largest land holding for TPWD, it covers nearly 270,000 acres in West Texas. It's a fragment, a big fragment, but still a fragment. To illustrate this fact, mountain lion research conducted on the area reveals that the average home range for adult male lions is over 200 square miles. When two or more male lions are involved, this means much more habitat than can be provided on the park alone. It doesn't take long to realize that even if enough money was made available to purchase land for public ownership, it would never be enough to make a substantial difference for conservation of some species in Texas.



As habitat in Texas continues to change, some wildlife species will decrease in number and some will increase. Certainly, nothing will remain the same. The job of resource managers is to balance the needs of all wildlife by providing the mosaic of habitats necessary to sustain populations over the long run. In Texas, many challenges and opportunities lie ahead as together we learn more about the natural history of lesser known species and integrate their needs into existing plans for private and public property.

"Urban Sprawl and its Effect on Rangeland Resources" will be highlighted at SRM's summer meeting in San Antonio. Those attending will look at rangeland resource management from a somewhat different perspective than the conventional. Field trips and programs dealing with water issues, endangered species, habitat restoration, and many other exciting and entertaining activities are planned as well. Come and be ready to enjoy yourself Texas style, learn a bit, and carry home lots of new ideas!

Authors are Nongame Program Leader, Texas Parks and Wildlife Department, 4200 Smith School Rd., Austin, Texas 78744, and Range Consultant from Canyon, Texas



# Rangelands of the Chang Tang Wildlife Reserve in Tibet

**Daniel J. Miller and George B. Schaller**

*A Tibetan nomad lady bundled up against the wind while herding.*

The Chang Tang Wildlife Reserve, in northwestern Tibet, includes one of the last, largely undisturbed rangeland ecosystems in the world and provides habitat for a diverse assemblage of wild ungulate species, several of which are endangered and endemic to the Tibetan Plateau. The southern and westernmost parts of the Reserve also afford grazing for Tibetan pastoralists and their livestock. Geographically isolated, and, until recently, off-limits to Westerners, the Reserve's rangelands and its wildlife have been little studied.

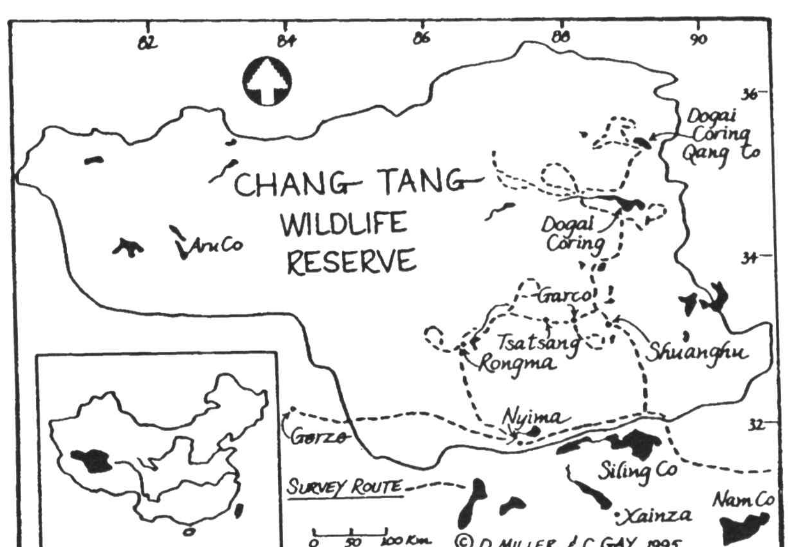
A cooperative wildlife conservation program in the Chang Tang Reserve between the Wildlife Conservation Society and the Tibet Forest Bureau began in 1988 with rangeland surveys and investigations on the distribution and status of wildlife, primarily large ungulates. This paper provides an overview of the rangelands, wildlife and pastoral production systems in the eastern part of the Chang Tang Reserve based on our research in the fall of 1993 and summer of 1994. We also discuss conservation issues facing the reserve and the implications these have for development, management and conservation.

## Description and Location

Located in the northwestern part of the Tibetan Autonomous Region (see Map 1), the Chang Tang Reserve encompasses approximately 110,000 square miles, (an area about the size of Arizona), and is the second largest protected area in the world. The Reserve is part of the *chang tang* (Tibetan for "northern plains"), the spacious steppes and mountains that sweep along northern Tibet for almost 800 miles east to west. The *chang tang*, a vast and vigorous landscape comparable in size to the Great Plains of North America, is one of the highest, most remote and least known rangelands of the world. The land is too cold and arid to support forests and agriculture; vegetation is dominated by cold-desert grasslands, with a sparse cover of grasses, sedges, forbs and low shrubs. It is one of the world's last great wilderness areas.

The Chang Tang Wildlife Reserve was established by the Tibetan Autonomous Region government in 1993 to protect Tibet's last, major wildlife populations and the grasslands they depend upon. In the wilderness of the Chang Tang Reserve large herds of Tibetan antelope still follow ancient trails on their annual migration routes to birthing grounds in the far north. Wild yaks, exterminated in most of Tibet, maintain their last stronghold in the mountains of the Reserve, and Tibetan wild ass still roam across the steppes. The reserve retains a grassland

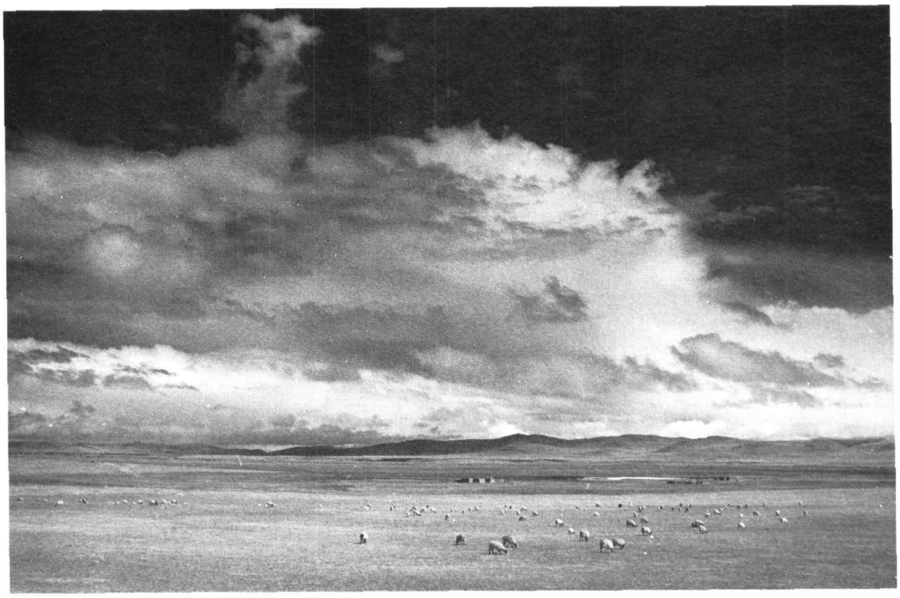
MAP 1



ecosystem largely unaltered by humankind, of broad, rolling steppes broken by hills and snow-capped mountains and large basins often with saline lakes.

There are no major rivers in the reserve; all drainage is internal. However, the headwaters of the Yangtze River are located just outside the reserve in the southeast. Most of the Chang Tang Reserve lies at elevations between 14,500 to 16,500 feet and a number of peaks rise to elevations over 20,000 feet. The Kunlun Mountains and the boundary of the Xinjiang Uygur Autonomous Region define the northern edge of the Reserve. The eastern limit of the Reserve follows the border of Qinghai Province. The "northern road", which crosses Tibet from east to west and continues to Xinjiang, marks part of the southern and western limit.

The climate of the Reserve is harsh with no frost-free season. Daytime temperatures in July and August may reach 75° F, but in most places, even in the height of summer, nighttime temperatures are often below freezing. Winters are extremely cold and windy with temperatures that drop below –40° F. Annual precipitation ranges from about 12 inches in the southeast to less than 4 inches in the northwest, and about 75 percent occurs during the months of July, August, and September, much of it as snow and sleet. Large areas have permafrost 2–3 feet below the surface and these may become quagmires in the summer, making vehicle travel difficult.



*Rangelands in the southern part of the Chang Tang Reserve at 14,500 feet used for grazing by Tibetan pastoralists.*

## Rangelands

We categorized the rangelands of the Reserve into three major vegetation types: alpine steppe, desert steppe, and alpine meadow. The alpine steppe is the dominant type in the southern half of the Reserve and provides the most important grazing land for wild ungulates and livestock. The desert steppe is found in the uninhabited northern part of the reserve and the alpine meadow is located mainly in the southeastern margin of the reserve and along streams elsewhere.

**Table 1. Composition of vegetation (by percentage) of plant communities in the eastern Chang Tang Wildlife Reserve, Tibet. Based on transects with a 0.25 m² circular plot. Fall 1993 survey.**

| | *Stipa*` Steppe | Mountain Meadows | *Carex* Steppe |
|---|---|---|---|
| Number of Plots | 180 | 60 | 40 |
| Average % Bare Ground | 84.5 | 76.4 | 89.4 |
| Average % Vegetation | 13.9 | 22.1 | 9.5 |
| Average % Litter | 1.6 | 1.5 | 1.1 |
| GRAMINOIDS | | | |
| Grasses | 61.9 | 29.7 | 42.8 |
| *Carex moorcroftii* | 3.0 | 5.3 | 38.6 |
| *Kobresia* spp. | 12.4 | 17.5 | 10.1 |
| FORBS | 17.8 | 35.0 | 6.4 |
| DWARF SHRUBS | 5.7 | 12.2 | 2.7 |

Much of the alpine steppe is dominated by a plant community characterized by a *Stipa*, often known as purple feathergrass for its long, feathery awns. Vegetation cover in these rangelands is usually a meager 10 to 15 percent. Two species of *Stipa* make up 50–60 percent of total vegetation composition. Other Gramineae include blue grasses and sedges, comprising another 15–20 percent of total vegetative composition. Common forbs were a tiny *Potentilla*, a species of *Leontopodium* and legumes of the genera *Oxytropis* and *Astragalus*; making up 10–15 percent of vegetation composition. Low to procumbent shrubs such as *Ceratoides compacta*, *Potentilla sp.*, *Myricaria prostrata* and *Ajania fruticolosa* are also found locally in *Stipa* rangelands.

In the alpine steppe, ungulates such as Tibetan gazelle are selective feeders, concentrating on particular forbs. Tibetan antelope, blue sheep and argali are mixed feeders, consuming both graminoids and forbs while the larger ungulates like wild yak and Tibetan wild ass consume mainly grasses. In winter, herds of wild ass and Tibetan antelope congregate on the extensive *Stipa* rangelands in the southern part of the Reserve.

On mountain slopes the alpine steppe flora tends to be more diverse than on the plains. In this type, grasses only make up about 30 percent of total vegetation composition and only about half of it is *Stipa*. Other grasses, such as species of *Elymus*, *Deyeuxia*, *Poa* and *Festuca* are also common, and species of *Kobresia* sedges often amount to 15 percent of total composition. A variety of forbs comprise 40 to 50 percent of total vegetative composition. These alpine grass-meadows provide forage for all species of wild ungulates including blue sheep and Tibetan argali.

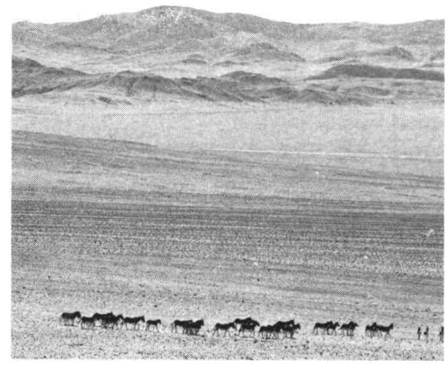
In the desert steppe, which extends across the northern part of the reserve, plant communities are often dominated by the sedge, *Carex moorcroftii*, and the shrub *Ceratoides compacta*. This type is found on sandier soils and although *Stipa* grasses are still part of the community they are eclipsed by *Carex moorcroftii*. The forb component in this type is also reduced, often making up only 5 percent of total vegetation composition. Expanses of *Carex* are more common as one travels north in the Reserve. Low sand dunes are sometimes found in these grasslands.

The alpine meadow vegetation type is found in the southeastern portion of the Reserve, which receives more precipitation, and also along rivulets elsewhere. Plant communities here are characterized by a thick turf or sod layer and vegetation is dominated by sedges of the genus *Kobresia*. These meadows usually have a rich forb component with genera such as *Bistorta, Gentiana, Pedicularis*. They are normally fed by snow and glacial melt springs. Such riparian areas initiate plant growth earlier than other habitats which depend on summer precipitation for growth.

We found rangelands in the reserve to be spatially heterogenous ranging from patch to landscape scales in composition, structure and productivity. Although fairly limited in overall plant species richness the rangelands are nevertheless quite diverse and provide habitat for six wild ungulate species and four domestic livestock species as well as a variety of large predators, small mammals and birds. The diversity in the vegetation is often subtle and easily overlooked, yet it is frequently the delicate differences that define movements and foraging behavior of both wildlife and domestic animals.

## Wildlife

The Chang Tang supports a unique community of large mammals that includes six wild ungulate species — *chiru* or Tibetan antelope, Tibetan gazelle, Tibetan argali, blue sheep, *kiang* or Tibetan wild ass, and wild yak. All but the blue sheep occur only on the Tibetan Plateau, and all probably evolved in this high and harsh environment. The Chang Tang Reserve now represents the last and best place affording most of these species a future.

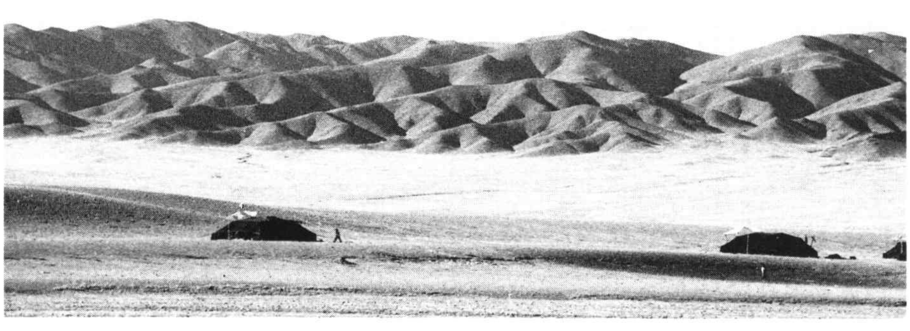


*Tibetan wild ass.*

We were especially interested to learn how the wild ungulates coexist. With plant species few and vegetation cover sparse, do the species compete for forage with each other and with livestock? The growing season is short, from late May or early June until September, making nutritious green forage only briefly available. To assess the impact of wildlife on the rangelands we had to census animals, plot distribution, and study food habits, the last by collecting droppings for analysis of plant fragments in them.

The chiru, more than other species, defines the Chang Tang ecosystem. A few small chiru populations are sedentary, but most animals are migratory. Chirus spend autumn and winter along the northern margin of the alpine steppe where forage is abundant. They rut there in December. In May, the pregnant females with their female offspring of the previous year migrate north, often in large herds numbering several hundred individuals, along traditional routes for as much as 200 miles to give birth in the high and desolate desert steppe.

Unlike chirus, Tibetan gazelles are sedentary. They are usually alone or in small herds, seldom more than a dozen animals. Though still widespread on alpine steppe, on plains as well as on hills, they are highly dependent on rangeland with a variety of forbs. Consequently gazelles congregate in certain localities and are absent from much of the desert steppe in the north.



*Tibetan nomad tents which are made out of yak hair and are designed to withstand the strong winds of the Tibetan winter.*

Blue sheep are fairly common, with herds sometimes numbering 50 or more animals. They prefer habitat near precipitous terrain, cliffs providing them with refuge from wolves, which limits their distribution. Argalis, large wild sheep, were rare, found only in a few places. Kiang are found mainly in the alpine steppe where they congregrate in herds of up to 300 animals in the fall, after the rut. For much of the summer, kiang roam singly or in small herds, usually with fewer than 25 animals.

Wild yaks prefer to be in mountains where they ascend to about 17,700 feet at the limit of vegetation. They are often found on slopes near glaciated peaks where there is fresh water, luxuriant plant growth along rivulets, and terrain that enables them to shift seasonally up and down slopes for the most nutritious forage. Bulls are often alone or in small all-male groups, whereas females with their offspring and any attending bulls are in herds with 10–25 members and occasionally as many as 100–200. Such herds roam widely, making seasonal shifts for 30 miles or more.

These 6 ungulate species overlapped broadly in their use of terrain, although blue sheep, argalis, and wild yaks were usually in mountains. All six fed on only a few plant species, mostly on *Carex moorcroftii* and two kinds of *Stipa* as well as on several forbs, including legumes of the genera *Astragalus* and *Oxytropis*, the cushion plant *Leontopodium pusillum* and the yellow flowered *Potentilla bifurca*. In summer, when forage is abundant and nutritious, competition is less likely than during the long winter when leaves are dormant or dead. We collected fecal samples for analysis in October when temperatures were at times 0° F and below and winds fierce. *Stipa* was at that time the principal feed of all species except gazelle and argali. The coarse and sharp-pointed *Carex moorcroftii* was much grazed by argali, blue sheep and chiru, but not kiang. There were almost no wild yak in our October survey area and we obtained fecal samples the following June farther north after vegetation had begun to green in places. At that time, yaks also ate *Carex*. Even with forbs and shrubs scarce and dry, gazelle, argalis, blue sheep, and to a lesser extent chiru, sought out these plants, a selection especially evident for the tiny *Potentilla*. There was some resource partitioning but considerable overlap remained. Diets differed in proportion of plant types they ate, not of plant species eaten.

*A typical nomad family maintains 500 sheep and goats and 20 yaks. Sheepskin clothing is worn throughout the year.*

The harsh and high steppes of the Chang Tang probably had a relatively low density of wildlife even in the past. Natural mortality is high. In October 1993 we noted that only about half of the chiru females had an offspring at heel and the following June only one female in three had a surviving young. Over half of the young had died in their first year of life, probably weakened by snow and wind shortly after birth and some killed by predators. Among the predators, snow leopard are rare, confined to a few rocky ranges, and lynx are uncommon. However, wolves remain widespread, even though much persecuted by herdsmen. Once we observed a lone wolf pursue a chiru herd and after a long chase pull down a female.

Small mammals, especially marmot and pikas are also important wolf prey. Pika colonies are ubiquitous. Unlike marmots, pikas do not hibernate and they thus are the year-round basic food of many predators from upland hawks and saker falcons to Tibetan sand foxes and brown bears; even wolves subsist on them when larger prey is unavailable. The wild ungulates have evolved to survive blizzards and predators but not the additional stress of unrestrained hunting by people.

## Pastoralists and Livestock Production in the Reserve

Although most of the Reserve is uninhabited, a belt of rangelands in the southern part supports pastoralists and their livestock who for centuries have managed to exist there, despite living in one of the world's harshest environments and at altitudes as high as any other people on earth. Today's northern-most grazing areas around the villages of Tsatsang, Garco and Shuanghu, however, were settled less than a quarter century ago by pastoralists who were moved north from the administrative center of Xainza. Today, there are about 3,500 nomad families and their livestock that depend upon grazing lands in the Reserve for a livelihood. The average size of a nomad family in the Reserve is a little over five members, making a total population of about 19,000 people. These nomads maintain an estimated 1.5 million head of livestock in the Reserve.

Domestic yaks, which are descended from wild yaks, provide milk, meat, fiber, and dung and are also used as pack animals. Although yaks characterize Tibetan pastoralism, sheep and goats are economically more important in the reserve. Sheep are milked for a few months in the summer and are also an important source of meat for nomads. Each nomad family will slaughter about 40 sheep every fall for its own consumption. Tibetan goats produce fine cashmere wool, which has increased greatly in value in recent years. Goats are also milked, giving more milk for a longer period than sheep.

Sheep are the most common domestic animal and comprise about 60 percent of the total livestock population, goats make up 30 percent, yaks about 8 percent and horses only 2 percent. Although the number of livestock per family varies considerably depending on range conditions, climate and an individual's animal husbandry skills, many herders interviewed in the south-central part of the Reserve maintained an average of 500 sheep and goats and 20 yaks. In the eastern edge of the Reserve, where rangelands are dominated by *Kobresia* sedge meadows and are more productive than the arid *Stipa* grasslands, the number of sheep and especially yaks maintained by nomads increases.

The survival of Tibetan nomads today indicates that many of the strategies of animal husbandry and grazing management developed centuries ago are well adapted responses to environmental conditions found on the harsh Tibetan steppes. The fact that most nomads continue to live, and live well, is proof of the rationality for many traditional Tibetan nomadic pastoral practices as a means to convert forage from cold, arid rangelands into valuable animal products.

## Management Issues

The steppes of the Reserve are one of the few rangelands in the world that have been little affected by man and his livestock. Yet, little is known about the nutritional status of forage species at different seasons, plant compositions and productivity in various habitats, and extent of monthly overlap in food habits between the various livestock and wildlife species. Much more information is also needed about current livestock herding and marketing practices. Without such data the impact of, for instance, kiang on the winter range is difficult to evaluate.

Pastoralists in some areas complain that kiang compete with their livestock for winter forage. Certain village cooperatives or *xiangs* have therefore requested that the government reduce the kiang population. Livestock and kiang indeed subsist mainly on *Stipa* during winter, and some competition for forage no doubt occurs, but there is little evidence of rangeland deterioration yet. So far, problems between livestock and wildlife are more perceived than real. Livestock numbers have not reached a level where it has degraded rangelands, except in the vicinity of a few villages; the rangelands remain in good condition. And there are now few wild ungulates.

Rangelands on alpine steppe that belonged almost exclusively to wildlife as recently as the 1960s are now settled, at least seasonally, to their northern limit. Beyond, good grazing is sporadic, mere islands in the arid desert steppe. Yet the government has plans to expand pastoralism north into this uninhabited terrain, into this area so marginal for livestock that previous attempts to settle there failed. In the 1970s, herders were moved to one northern site. They left within a year because of water scarcity and remoteness, but not until they had killed many wild yaks, judging by the litter of skulls we found. Starting in the 1990s, a few herders began to enter the Dogai Coring area illegally from Qinghai Province. Patches with good grazing in these inhospitable uplands are critical to the survival of wildlife. With the alpine steppe now essentially usurped by pastoralists, the northern part of the reserve represents the last real refuge for wildlife and especially for the wild yak, wolf, and bear.

The future of the rangelands and the wildlife in the reserve as well as the traditional life of the pastoralists will depend on innovative management programs. Any such policies and programs need to address the basic issue of coexistence between livestock and wildlife and they need to be designed with the goal of maintaining the reserve as a viable and undamaged ecosystem. They must also be flexible enough to address specific local problems. For example, kiang are perceived to be serious competitors of livestock in a few localities but not the reserve as a whole. How can such issues be resolved?

Commercial hunting for yak meat and chiru wool is a major problem. Unregulated hunting in the last few

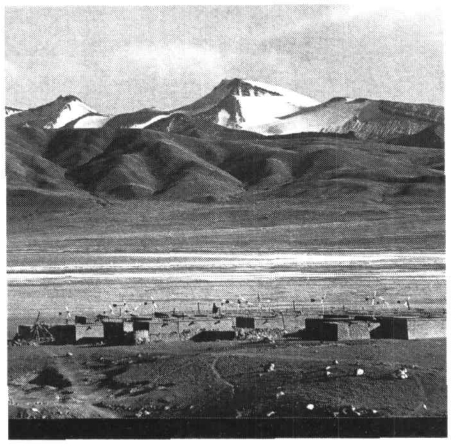
*Young nomad boy taking care of the family's flock of goats. The goats are tied up for milking.*

decades has ravaged wild yak and chiru populations in the more accessible, southern parts of the Reserve. Reserve staff are still poorly equipped and trained to control this illegal hunting.

The Tibet government is concerned about wildlife conservation, especially for the kiang, chiru, and wild yak which are fully protected. The reserve is viewed as a multiple-use area where the needs and aspirations of the local people must be considered. Fortunately there is time to develop a plan that will permit the great wild herds, the livestock, and the people to coexist. To achieve this goal, several actions are needed: (i) illegal commercial hunting must be controlled; (ii) any future oil drilling and gold mining must be strictly regulated and monitored to avoid excessive damage to the environment; (iii) the uninhabited northern areas of the reserve should be wholly reserved for wildlife and all human access prohibited except by special permit; (iv) the building of fences that hinder the free movement of wildlife should be prohibited; (v) since livestock is in a reserve whose explicit purpose is to protect wildlife, there will have to be limits placed on the number of livestock allowed, at least in some areas at certain seasons, such as chiru breeding grounds; (vi) the reserve should be made a UNESCO Biosphere Reserve to promote greater international awareness and cooperation; and (vii) major research should be conducted *before* rangelands are damaged.

## Conclusions

The fact that grand herds of wildlife and a prosperous pastoral culture remain on the rangelands of the southern part of the Chang Tang Wildlife Reserve bears witness to the remarkable diversity and resilience of this unique ecosystem. These rangelands, however, are coming under increasing pressure from an expanding human population and rapidly increasing development yet, properly managed, they could continue to provide critical habitat for wildlife as well as grazing land for sustainable livestock production.



*The Tibetan settlement of Garco at 16,000 feet. One of the most northern inhabited areas of the Reserve.*

Strategies for range management, wildlife conservation, and pastoral development in the Chang Tang Wildlife Reserve should foremost aim to maintain the condition of the rangelands and protect biodiversity. To achieve this goal it will be necessary to develop strategies for sustainable livestock production that take into account the needs of wild ungulates and other wildlife as well as the aspirations of the local people. Developing such strategies requires a much better understanding of ecosystem dynamics, more information on the status, distribution and ecology of wildlife, increased knowledge of pastoral production practices, more thorough analysis of the issues and opportunities facing pastoralists, and modifications in policies and current approaches to management of the rangelands. These actions are crucial for saving the wildlife and their habitat and for ensuring sustainable pastoral development in the face of growing threats from modernization.

The remarkable steppes of the Chang Tang Wildlife Reserve will experience a great and tragic barrenness if the rangelands are degraded. Unique wildlife populations will be severely threatened and equally unique pastoral cultures will be transformed beyond recognition. With imaginative planning and cooperation of the pastoralists, the Chang Tang can be managed in the kind of ecological harmony that is the basis of Tibetan Buddhism.

## Additional Reading

**Cincotta, R.P., P.J. van Soest, J.B. Robertson, C.M. Beall, and M.C. Goldstein. 1991.** Foraging ecology of livestock on the Tibetan *Changtang*: A comparison of three adjacent grazing areas. Arctic and Alpine Research, 23(2):149–161.

**Goldstein, M.C. and C.M. Beall. 1990.** Nomads of Western Tibet: The Survival of a Way of Life. Odyssey, Hong Kong.

**Goldstein, M.C., C.M. Beall, and R.P. Cincotta. 1990.** Traditional nomadic pastoralism and ecological conservation on Tibet's northern plateau. National Geographic Research, 6(2):139–156.

**Harris, R.B. and D.J. Miller. (in press)** Overlap in summer habitats and diets of Tibetan Plateau ungulates. Mammalia.

**Miller, D.J. and D.J. Bedunah. 1994.** Rangelands of the Kunlun Mountains in Western China. Rangelands, 16(2):71–76.

**Schaller, G.B. 1993.** In a high and sacred realm: Tibet's remote Chang Tang. National Geographic, 184(2):62–87.

**Schaller, G.B. and Gu Binyuan. 1994.** Comparative ecology of ungulates in the Aru Basin of Northwest Tibet. National Geographic Research and Exploration, 10(3):266–293.

**Schaller, G.B., Ren J., and Qiu M. 1991.** Observations on the Tibetan antelope (*Pantholops hodgsoni*). Applied Animal Behaviour Science, 29:361–378.

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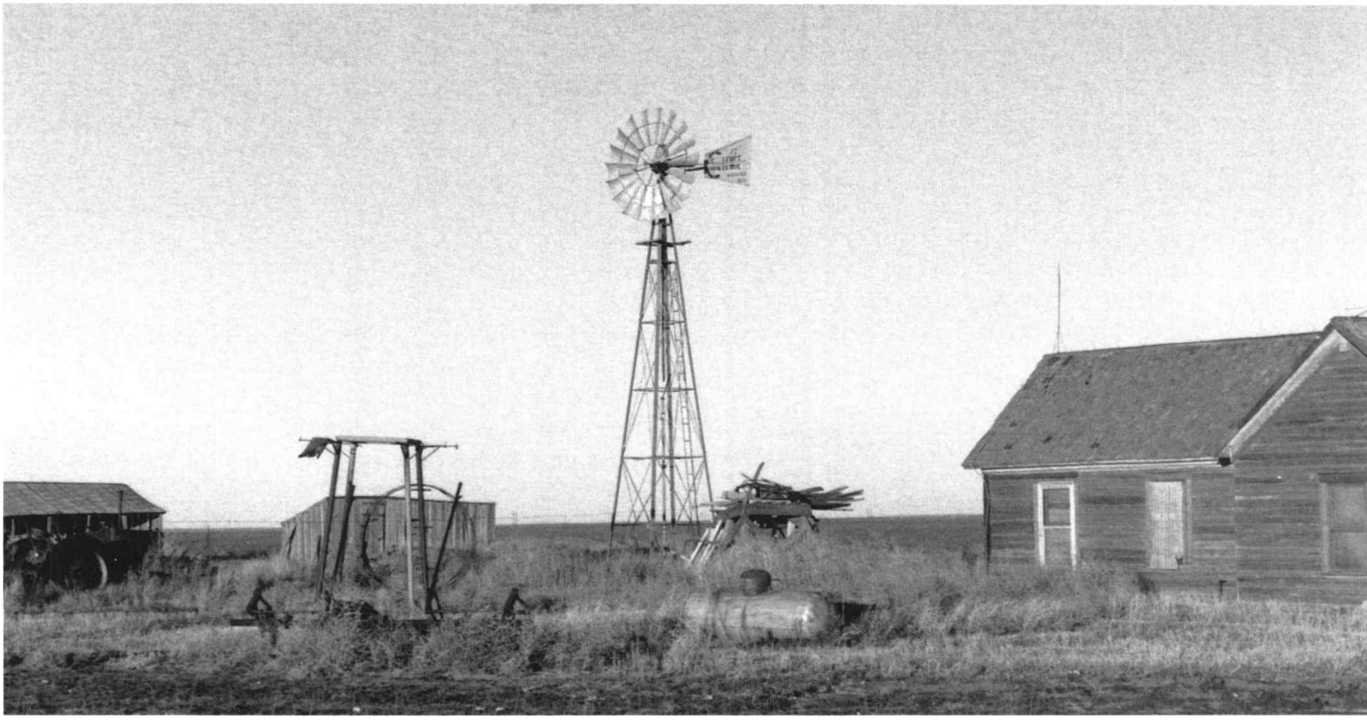


*Windmills in use.*

# Windmills or Solar Watering Systems

**M. Wade Polk and R. T. Ervin**

In many parts of the American Southwest livestock producers are faced with an inadequate water supply on a regular basis. Ranchers are often faced with the decision of choosing a means of providing water in remote areas. Many have learned to depend on the windmill for supplying water. Although the electric submersible pump has also been used for watering livestock, this option is not always economical for isolated areas lacking a ready source of electrical power.

Windmills seen on many farms and ranches throughout the U.S. were developed in the 1860's (Torry 1976). These windmills have a horizontal-axis rotor, often called head-on machines, meaning that the axis of rotation is parallel to the direction of the wind. Railroads were one of the early users of windmills to fill water tanks for locomotives. Ranchers and homesteaders used them to irrigate. There are approximately 150,000 windmills in the United States, with the majority being located in western rangelands (Cheremisinoff 1978). A major problem associated with windmills is the variability of wind which causes some water needs to be unmet when the wind quits blowing.

An alternative source of power for water delivery is the newly developed solar powered watering system. The solar water system traps sunlight on a photovoltaic panel, converts the sunlight to electricity, which powers a submersible pump.

Windmills and solar water systems represent alternative means to pump ground water. However, given these 2 alternatives, the question remains, which is the most cost-effective means of delivering water to the livestock? One system, solar, may have a relatively low initial cost, and a relatively short expected life; the other system, windmills, may have a relatively high initial cash outlay, and a relatively long expected life.

### Scenario

A representative farm or ranch watering scenario is assumed for the purpose of comparing the windmill to the solar water system. The depth of the well is 100 feet and both water systems are able to produce approximately 800 gal/day. The following assumptions are made: (1) the well is in place; (2) there is no electricity at the well site; (3) both systems will pump enough water to meet the needs of the producer; and (4) the producer wishes to minimize costs.

The initial investment and maintenance costs of the 2 systems were obtained from distributors of the systems

(Table 1). The initial cost of the windmill system represents the windmill motor, tower, cylinder, drop pipe and sucker rod. The initial cost of the solar water system represents the photovoltaic cell, stand, wires, submersible pump and drop pipe. The expected useful life of the windmill ranges from 30 to 70 years, while the solar water systems are expected to last 10 years. Prices for new windmill equipment range from approximately $4,000 to $5,000, and the solar water systems range from $2,500 to $3,000. Thus, while one system offers a relatively long expected useful life the other system offers a reduction in initial cash outlay.

**Table 1. Costs of watering systems**[a]

| **WINDMILLS**: Projected Annual Maintenance Expense is $34.14 | | |
|---|---|---|
| New Price | Used Price | Useful Life |
| $4,708.00[B] | $3,132.00 | up to 70 yrs |
| $4,033.00 | N/A | 30 to 50 yrs |
| $4,968.00 | $3,868.00 | 50 to 70 yrs |

**SOLAR WATERING SYSTEMS**: Projected Annual Maintenance Expense is $32.76

| New Price | Useful Life |
|---|---|
| $,2,500.00 to $3,000 | 10 yrs |

[a]Sources:
Aermotor Windmill Corporation, P.O. Box 5110, San Angelo, Texas. (915)651-4951
Allen Pump Hwy. 82 E., Ralls, Texas. (806) 253-3656
Dempster Industries Inc., 4709 Clovis Hwy., Lubbock, Texas. (806) 765-9393
Robinson Solar Systems, Canton, Okla. (405) 886-3529
Topper Co. 1508 Beacon, San Angelo, Texas. 1-800-775-3277
[B]Two sources reported this price.

The projected annual maintenance expense of the windmill was estimated as the sum of the oil required for annual maintenance, and the annualized cost of replacing the leathers every 5 years. One quart of oil is required for annual maintenance, $4.25/quart. It is assumed that it takes approximately 30 minutes to replace the oil, $4.25/hour. The total annual cost of replacing the oil is $6.38/year. It is assumed that it will take 3 hours to pull the well to replace the leathers costing $52.50/hour for the well pulling rig and labor. It is also assumed that there are 4 leathers requiring replacement which cost approximately $3.00/leather. The total cost of replacing the leathers every 5 years is estimated to be $169.50. Windmill owners expecting to spend $169.50 every 5 years to replace the leathers could accumulate this amount if they were to save $27.76/year at 10% annual interest. This value is estimated as the annuity required to build a future value of $169.50 at 10% interest rate for a period of 5 years (Barry et al. 1979). Therefore, the annual estimated maintenance expense for the windmill is estimated to be $34.14.

In the solar system, the pump will require replacement every 5 years at a projected cost of $200.00. The pump owner would expect to spend $200.00 after the first 5 years of service to replace the pump. After the second 5 year period the producer replaces the entire solar water system, so replacement of the pump is not considered during this period. Producers could accumulate this amount if they were to save $32.76/year during the first 5 years of service at 10% annual interest. This value is estimated as the annuity required to build a future value of $200.00 at 10% interest rate for a period of 5 years (Barry et al. 1979). Therefore, the annual estimated maintenance expense during the first 5 years of service for the solar water system is estimated to be $32.76.

**Comparing Investments with Different Economic Lives**

When evaluating investment alternatives with different economic lives, it is necessary to (a) estimate the present value of cash flows over the respective economic lives; and (b) convert the present values to annuity equivalents. Because the economic lives differ between the water systems, the present values of cash flows are not comparable. The annuity equivalents allow for a comparison between the systems by determining the size of the annual annuity required for the economic life of the investment that should be provided to be equal to the present value of its projected cash-flow stream, given the cost of capital. An annual discount rate of 10% is assumed.

The Equation used to estimate the present value of the cost of the systems is:

$$V = \text{Initial Cost} + \text{Annual Cash Outflows}\left[\frac{[1-(1+i)^{-T}]}{i}\right]$$

where
V = present value of the cost of the systems
$i$ = annual discount rate assumed to be 10%
T = number of years the annual cash outflows are considered

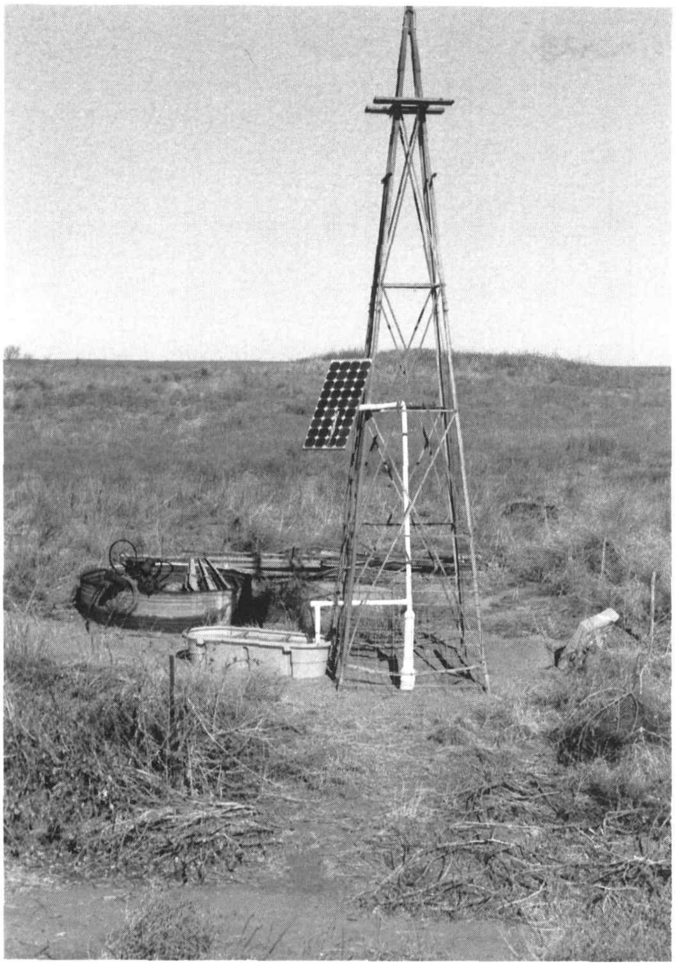
Present Value of Solar Water Systems: Assuming the initial cost of $3,000.00, the present value of the cost for the solar water system is estimated to be $3,124.19. This value includes the present value of the cost of establishing the solar water system with an expected economic life of 10 years plus annual maintenance of $32.76 during the first 5 years of service.

Present Value of Windmills: Assuming the initial cost of $4,708.00, the present value for the windmill water system is estimated to be $5,046.49. This value includes the present value of the cost of establishing the windmill with an expected economic life of 50 years plus annual maintenance of $34.14.

Because the economic lives differ between water systems the present value of cash flows is not comparable necessitating the annuity equivalents. The equation used to estimate the annuity equivalents for the above present values is:

$$V=A\ \frac{[1-(1+i)^{-N}]}{i}$$

where
A = annuity equivalent
N = number of years the system is expected to work.



*Windmills converted to solar water systems.*

Thus, the annual value of the annuity equivalent for the solar water system is $508.45 and for the windmill water system is $508.98. Given the assumptions made for this analysis and the difference in the annual annuity the cost of the systems is essentially equal.

**Sensitivity of Results:**

The above results may be dependent upon the values of the components initially considered. Thus, in an effort to determine whether the results may change if the initial values were to change, the following scenarios are constructed and estimated: (1) base scenario representing those values used to develop the above results: all succeeding scenarios reflect changes to the base, (2) reduce initial cost, (3) increase annual maintenance cost, (4) increase the discount rate, (5) decrease the discount rate, and (6) reduce the expected working life of the respective water system by 40%.

Changing the initial cost of the systems to the lowest reported costs causes the solar water system to be $13.83/year less costly than the windmill. When the cost of annual maintenance is increased to $50 for each system, the advantage ($5.76) remains with the solar water system. Increasing the discount rate to 12%, results in the advantage again being held by the solar water system by $49.21/year for the life of the system, while decreasing the discount rate to 8%, results in the advantage shifting to the windmill by $47.59/year. Finally, reducing the expected working life of both systems by 40%, results in an annualized equivalence value of the solar water systems costing $25.11/year less than the windmill.

Comparing the 2 net-present values coupled with the economic lives of each system, using the annuity-equivalent method, the discount rate and expected useful lives of the systems found which system is the most cost effective investment. However, ranchers and livestock producers should evaluate their circumstances before choosing one of these watering systems. The windmill is a trademark of western rangelands and may represent romantic and/or nostalgic value to some people. Many replacement parts for windmills are readily available, with installation relatively simple (Hayes and Allen 1983). Generally the windmill is permanently placed and not easily moved, while many solar water systems are capable of easily being moved from one well to another. On the other hand, lightning strikes will effect the two water systems differently. A windmill struck by lightning will generally continue to pump water whereas a solar water system would be expected to need repair.

Whether the discount rate is above or below 10% is anyone's guess. If the rancher is pessimistic on the direction of the economy and expects the discount rate to be above 10%, then the solar water system would be the most economical investment. The optimistic rancher, expecting the discount rate to be at or below 10% might choose the windmill. However, producers must seek the best system for their specific needs.

## References

**Barry, P.J., J.A. Hopkin, and C.B. Baker. 1979.** *Financial Management in Agriculture* Second ed., The Interstate Printers & Publishers, Inc., Danville, Illinois.

**Cheremisinoff, N.P. 1978.** *Fundamentals of Wind Energy*; Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan.

**Hayes, D., and B. Allen. 1983.** *Windmills and Pumps of the Southwest.* Eakin Press, Austin, Texas.

**Torry, V. 1976.** *Wind-Catchers: American Windmills of Yesterday and Tomorrow*; The Stephen Greene Press, Brattleboro, Vermont, N.H.

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# Preventing Noxious Weed Invasion

**Roger Sheley, Mark Manoukian, and Gerald Marks**

Thirty-two alien weed species infest over 6.5 million acres of rangeland in Montana and they are advancing at an alarming rate. Fifteen of those species are declared noxious by the state of Montana. The most serious weed is spotted knapweed which infests about 4.5 million acres (Figure 1). It has been estimated that spotted knapweed has increased at a rate of 27% per year since 1920 and has the potential to invade another 34 million acres in Montana alone (Figure 2).

Noxious weeds introduced into Montana during the 1950's, such as leafy spurge, whitetop, and diffuse knapweed are also spreading onto rangelands. Newly introduced noxious weeds, such as common crupina, rush skeletonweed, and Dyer's woad are encroaching into Montana from neighboring states. Yellow starthistle is spreading at a rate of about 25,000 acres per year in Washington and Idaho and is quickly advancing toward Montana. These noxious weeds have the ecological potential to invade nearly all of Montana's rangelands as well as many areas in other states.

The most effective method for managing noxious weeds is to prevent their invasion using a combination of methods aimed at limiting encroachment. Methods of preventing noxious weeds from spreading are:

* Limiting weed seed dispersal
* Containing neighboring weed infestations
* Minimizing soil disturbances
* Detecting and eradicating weed introductions early
* Establishing competitive grasses
* Properly managing grasses

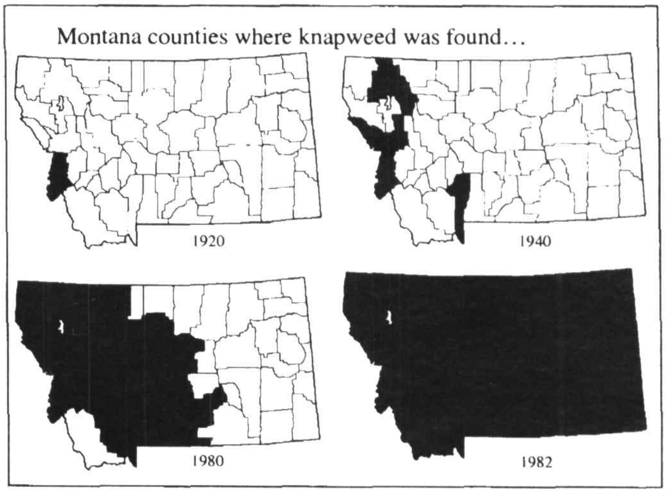


**Fig. 1.** *Spotted knapweed was first reported in the western part of Montana in the 1920s. Since then it has spread to every county.*

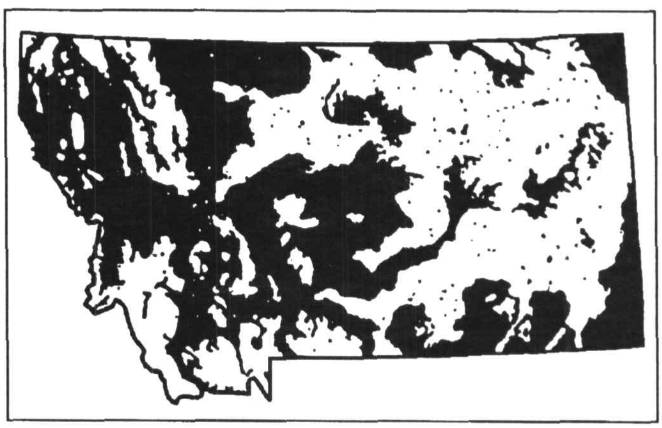

**Fig. 2.** *Black areas are part of Montana where there is a high probability that spotted knapweed will grow (if it isn't already), based upon the conditions found in 116 knapweed infestations.*

### Limiting Weed Seed Dispersal

Noxious weed seeds are often carried along roadways in the undercarriage of vehicles. A Montana State University study showed that a vehicle driven several feet through a spotted knapweed infestation could pick up about 2,000 seeds. Only 10% of the weed seeds remained on the vehicle 10 miles from the infestation. Similarly, weed seeds are dispersed by machinery. Limit noxious weed seed dispersal by refraining from driving vehicles and machinery through weed infested areas during the seeding period. Wash the undercarriage of vehicles after driving through an area infested with a seed producing noxious weed. Control emerging weeds in the wash-up area.

Wildlife and livestock disperse seeds two ways. First, animals ingest noxious weed seeds which can pass through the stomach unaffected, introducing seeds into new areas. Second, many weed seeds can become tangled in the haircoat of animals and fall to the ground when animals are moved to weed-free areas. Little can be done to limit weed seed dispersal by wildlife. Livestock should not graze weed infested areas during flowering and seeding, or be transported to a holding area for about 14 days after grazing weed infested areas before being moved to weed-free ranges. Sheep and goat grazing must be properly timed and managed to prevent seed production.

Noxious weeds can be dispersed in feed. This can be a major problem where recreational horseback riding and hunting are permitted, but can be a problem for ranchers as well. Using only feed that is certified free of noxious weedseeds is one method of preventing the introduction of noxious weeds. Grinding and pelleting forage or grain will also reduce the chances of introducing noxious weeds.

Hikers, campers, and recreationists can spread noxious weed seeds on their clothing as they pick the flowers and discard the wilted parts along trails and recreational access sites. Once discarded these plants continue seed development. Clothing and camping equipment should be brushed and the discards placed into a hot fire before leaving an area. Prudence in limiting weed seed dispersal is critical for all recreationists.

### Containing Neighboring Weed Infestations

An integral part of any weed prevention program is to contain neighboring weed infestations. The most effective method of containment is to spray borders of the infested areas with a herbicide. Concentrate efforts on the advancing edge of the weed infestation. Containment programs typically require a long-term commitment to herbicide application because they are not designed to eliminate or reduce the infestation level, only to limit its spread. Roadways, railways, and waterways, where weed infestations often begin, should be under a constant prevention and containment program.

### Minimizing Soil Disturbances

Areas of disturbed soil provide an optimal location for noxious weed establishment and subsequent invasion. Noxious weeds are alien to North America and have evolved under highly disturbed conditions. Noxious weeds have developed many characteristics, such as rapid growth rates, high seed production, and extended growing periods, which provide them an advantage over native North American plants in occupying disturbed soil. Minimizing soil disturbance by vehicles, machinery, wildlife, and livestock is central to preventing noxious weed establishment.

### Detecting and Eradicating Weed Introductions Early

Preventing and controlling noxious weed encroachment depends on early detection. Survey the area, identify and remove any individual weed plants before they become well established. A survey plan should be developed for each management unit which includes inventory techniques (vehicle, horseback, motorcycle, foot), area surveyed, and survey time periods. At least three surveys should be conducted each year. A spring survey to detect weeds early enough to allow effective chemical control, the second survey in early summer and the last survey in early fall. At each survey both new and old noxious weed introductions should be hand removed (individual plants) or sprayed with the appropriate herbicide. It is critical to prevent weed seed production. Once weeds have produced a flower, chemical applications generally do not prevent seed production, and hand removal is usually necessary. Hand pulled plants should be burned. The weed infestation should be identified on a map, marked or flagged in the field, continually monitored, and controlled during subsequent surveys.

### Establishing Competitive Grasses

Another method for preventing encroachment is to establish competitive desirable grasses in areas susceptible to invasion. Competitive grasses limit the establishment and growth of weed populations by using resources needed by weeds. Well established grass stands are central to limiting weed encroachment along roadways. Specific establishment techniques depend upon the weed/grass complex and environmental characteristics of the site. In areas with a good residual (suppressed) perennial grass stand, chemical weed control (2,4-D, Banvel, Tordon 22K) may stimulate grass growth enough to allow site re-occupation. Severe weed infestations may require revegetation.

### Properly Managing Grasses

On areas with a competitive grass stand, proper management insures that they remain strong and vigorous. In most cases, grasses require defoliation every two to four years to remove old stems which shade plants and hinder growth. Mowing, burning, and grazing are the primary methods for defoliating grasses. Grasses are generally mowed in the summer or fall. Burning is conducted in the fall or early spring before the grasses resume growth. Defoliation stimulates grass growth and enhances their competitive ability.

Proper livestock grazing can be an effective means to maintain competitive grass plants. A grazing management plan should include proper stocking rates to maintain a grass stand. Furthermore, the plan should include a grazing system which outlines the movement of livestock throughout the year. Grazing systems should include altering the season of use, rotating livestock to allow plants to recover before being regrazed, and promoting litter accumulation. Grazing in this manner enhances the vigor and strength of the grasses which in turn limits weed germination and promotes early mortality of seedlings and rosettes. Any grazing management plan should include a monitoring program to determine the efficacy of the grazing system in protecting grasses and limiting weed invasion.

## Summary

Montana and many rangeland areas are being invaded by noxious weeds. The most economical and ecologically sound method for managing noxious weeds is to prevent their invasion by using the following guidelines. Noxious weed dispersal must be limited, and neighboring weed infestations contained. Soil disturbances must be minimized. New weed introductions must be detected early and eradicated. Finally, proper grass establishment and management must be implemented.

Authors are Extension Noxious Weed Specialist, Montana State University, Bozeman, Mont.; Prairie County Extension Agent, Terry, Mont.; and Missoula County Extension Agent, Missoula, Mont., respectively. Published with approval of the director, Montana Agricultural Experiment Station, as Journal No. 4061.

# Grazing Lands: Prices, Value, and the Future

**Jerry L. Holechek and Karl Hess, Jr.**

Western cattle ranches have been one of the most volatile of all assets ever since their development in the 1870s. Enormous profits were made by the early cattlemen due to the availability of cheap land in the West and rapidly expanding demand for beef in the industrializing East. This favorable situation reached its peak during World War I (1914–1918) when agricultural capacity in Europe was severely reduced and industrial demand exploded. Since 1920 the trend in profitability of western cattle ranching has been in a gradual decline with periodic reversals such as during World War II, the Korean War, and the Vietnam conflict (Holechek et al. 1994).

Historically western grazing land values have followed the general business cycle in the country with peaks generally occurring during periods of prosperity and bottoms occurring during recessions. The 1970s were a particularly favorable period for western grazing land values because of a loose monetary policy by the federal government that caused double digit inflation. This caused investors to dump financial assets such as stocks and bonds and buy real assets such as farmland, ranches, gold, and various agricultural commodities (beef). Many ranchers realized a 10 percent or more annual increase in the value of their ranches from 1968 to 1981. However this situation was rapidly reversed when the Reagan administration brought inflation under control by raising real interest rates to historic highs (Holechek et al. 1994).

## Fair Market Value for Western Ranches

We have calculated the present value on a per acre basis for different types of western grazing lands based on their recent earnings (1989–1993) and the average historic corporate PE multiple of 15 (Pring 1992) (Table 1). These val-

**Table 1. Forage production, financial returns, and fair market value of grazing land in good range condition using the 1989–1993 cost price structure.**

| Range type | Type of operation | State | Forage production (lb./acre) | Financial returns ($/acre) | Fair market value ($/acre)[1] |
|---|---|---|---|---|---|
| Southern pine forest | Cattle-cow | Louisiana | 2500-4000 | 8-14 | 120-210 |
| Tallgrass prairie | Cattle-cow | Kansas | 2500-3500 | 9-12 | 135-180 |
| Coastal prairie | Cattle-cow | Texas | 2500-3500 | 9-12 | 135-180 |
| Coastal prairie | Wildlife/cattle (W/C) | Texas | 2500-3500 | 25 (15 W + 10 C) | 375 |
| Southern mixed prairie | Cattle-cow | Texas | 2000-3000 | 6-8 | 90-120 |
| Southern mixed prairie | Cattle/wildlife (C/W) | Texas | 2000-3000 | 17 (10 W + 7 C) | 255 |
| High plains-shinnery | Cattle-cow | New Mexico | 800-1700 | 3-4 | 45-60 |
| Oak-savannah | Sheep/goats | Texas | 2000-3000 | 8-14 | 120-210 |
| Oak-savannah | Wildlife/cattle (W/C) | Texas | 2000-3000 | 28 (20 W + 8 C) | 420 |
| Shortgrass prairie | Cattle-cow | New Mexico | 800-1400 | 4.50-5.50 | 68-83 |
| Shortgrass prairie | Cattle-yearling | New Mexico | 800-1400 | 4-10 | 60-150 |
| Shortgrass prairie | Sheep | Wyoming | 600-1000 | 3.80-4.50 | 57-68 |
| Desert prairie | Cattle/sheep | New Mexico | 500-900 | 2.50-3.50 | 38-53 |
| Northern mixed prairie | Cattle-cow | Montana | 900-1600 | 2.50-3.00 | 38-45 |
| Annual grassland | Cattle-cow | California | 300-1500 | 1.00-3.00 | 15-45 |
| Palouse prairie | Cattle-cow | Oregon | 500-800 | 1.25-2.50 | 19-38 |
| Palouse prairie | Wildlife/cattle (W/C) | Oregon | 500-800 | 4 (2.50 W + 1.50 C) | 60 |
| Chihuahuan desert | Cattle-cow | New Mexico | 300-700 | 0.60-1.00 | 9-15 |
| Sonoran desert | Cattle-cow | Arizona | 100-400 | 0.30-0.60 | 5-9 |
| Salt desert | Sheep | Utah | 150-350 | 0.30-0.70 | 5-11 |
| Salt desert | Cattle-cow | Nevada | 150-350 | 0.15-0.40 | 2-6 |
| Mojave desert | Cattle-cow | California | 50-200 | 0.10-0.30 | 1-5 |
| Big sagebrush | Cattle-cow | New Mexico | 250-500 | 0.50-0.80 | 7-12 |
| Big sagebrush | Cattle-cow | Wyoming | 300-800 | 1.00-2.00 | 15-30 |
| Big sagebrush | Cattle-cow | Nevada | 150-400 | 0.50-1.50 | 7-23 |
| Piñon juniper | Cattle-cow | New Mexico | 100-500 | 0.25-1.00 | 4-15 |
| Coniferous forest | Cattle-cow | Eastern Oregon | 400-800 | 2.00-3.00 | 30-45 |
| Coniferous forest | Cattle-cow | New Mexico | 400-1000 | 2.40-3.00 | 36-45 |

Source: Holechek and Hess 1993.
[1]Fair market value in the 1989-93 per acre earnings multiplied by 15. Historically investors on average have paid 15 times annual earnings for corporations in America.

ues likely overstate the current fair market value of grazing lands because cattle prices have dropped 30% from the 1989-93 peak and cattle ranching is a mature rather than growing industry. Realtor listings in various parts of the country in the 1989–1993 period and valuations from New Mexico State University experiment station reports (Table 2) indicate that the asking prices for grazing lands exceeded the market values by 10 to over 100 percent, but there were many exceptions. Ranches in the central Great Plains were generally near fair value, but those in the intermountain West carried hefty premiums over what their earnings potential alone would seem to justify (Table 2). Our analysis of actual sale prices in the intermountain West reflect primarily what buyers were willing to pay for private rangeland. We believe these prices are inflated when applied to public grazing permits. This is because on public land the permittee does not have development or sub-division potential. Further there is now considerable uncertainty on BLM and Forest Service lands over what grazing fees and regulatory policy will be in the future.

**Table 2. Fair market value based on returns from livestock production and actual value (1993–95) of New Mexico rangeland using the 1989–93 cost-price structure[1].**

| Range type | Type of operation | Net returns per acre ($)[2] | Fair market value ($/value) | Actual market value ($/acre) |
|---|---|---|---|---|
| Shortgrass prairie | Cow-calf | 5.00 | 75.00 | 85.70 |
| Chihuahuan desert | Cow-calf | 0.70 | 10.50 | 30.00 |
| Sagebrush grassland | Cow-calf | 0.60 | 9.00 | 22.00 |
| Pinon-juniper | Cow-calf | 0.75 | 11.25 | 31.50 |
| Desert prairie | Cow-calf | 2.50 | 37.50 | 39.00 |
| Shortgrass prairie | Cattle-yearling | 5.00 | 75.00 | 84.00 |
| Desert prairie | Cow-calf/sheep | 3.00 | 45.00 | 32.00 |

[1]Actual value reflects what buyers actually were willing to pay for these grazing lands in the 1989-1993 period based on New Mexico State University experiment station reports, and interviews with real estate agents..
[2]Returns are for rangeland in good ecological condition.

## Influence of Range Condition on Rangeland Value

In the present pricing of rangeland the true grazing capacity does not appear to be fully reflected in prices. Realtors across the West, report no definite pricing premium for rangeland in excellent or good condition compared to rangelands in fair ecological condition. However, there has been some recognition in sales prices that rangeland in poor condition is less valuable than rangeland in fair to excellent condition. For instance ranch sellers routinely did not differentiate the value of land dominated by black grama or blue grama from land dominated by tobosa grass or threeawn. However it was generally recognized that lands with high amounts of bare soil and/or brush were less valuable than those with a grass cover.

## Influence of Infrastructure on Rangeland Value

It is our experience that most realtors and sellers give fairly reasonable unit appraisals to watering points and fences on western ranches. However pricing inefficiencies center around the optimal balance between the quantities of infrastructure and the amount of grazing capacity. There has been a historic tendency to substitute watering points and fence for grass when ranch grazing capacity is established. Knowledgeable buyers look for ranches with minimal infrastructure and high amounts of forage. They know that it is usually much cheaper to create infrastructure than increase forage. On most arid land ranches in the Chihuahuan desert or sagebrush types infrastructure costs become excessive relative to potential earnings when watering points exceed a 2 1/2 mile spacing and the average pasture size is less than 2,000 acres (Holechek and Hawkes 1993). In the more productive prairie areas of the Great Plains average watering point spacings under two miles and pasture sizes of less than a section would usually represent excessive capitalization. However it is important to point out that more infrastructure is justified on ranches with high grazing capacity than those that are degraded, or have low forage production potential. Fence and watering points improve the efficiency of range forage use. As forage production per acre increases, there is more potential to increase financial returns from improvements in forage harvest efficiency with fence and water development (Holechek 1992). The key here is to know future value of the extra forage that can be used compared to the cost of the infrastructure. As a general rule additions to infrastructure should come after increases in forage productivity rather than proceed them.

## When to Buy

Historically the time to buy any commodity based asset has been when the selling price of that commodity nears or drops below production costs (Casey 1993). The last good buying opportunity for western cattle ranches occurred in the 1985–86 period but another one will likely occur sometime between 1997 and 1999. A cumulative 3–4 year period (beginning in 1994) of unfavorable cattle prices will probably force most marginal ranching operations into liquidation. Most western ranches experienced negative financial returns from cattle in 1994 and 1995. Another reason that this could be a bottom has to do with the nation's economy, and this merits a separate discussion.

## Western Real Estate and Debt: An Accident Waiting to Happen

Many investors are now concerned that the massive building boom throughout the western United States since 1992 will end in a bust (Casey 1993, Davidson and Rees-Mogg 1993). Since 1991 credit institutions dropped the down payment requirements on home purchases from 10% to 0–5% because the federal government indirectly agreed to stand behind these risky, low equity loans through guarantees to home mortgage companies. In addition, there was a drop in credit standards for home purchase.

Values of rangeland and farmland have historically been closely tied to housing values. Drops in housing values were associated with even greater drops in agricultural land values in the 1930s depression and later during the 1981-82 recession (Casey 1993, Knutson et al. 1995).

Ever since the late 1960s more pessimistic analysts have predicted that consumer and public debt expansion in the United States would lead to a severe economic depression (Davidson and Rees-Mogg 1993). However the day of reckoning has been delayed by productivity increases, inflation and a wide variety of innovative ways to expand credit. Based on history, all debt is leveled sooner or later by payback, default, and/or inflation. Many economists believe the greatest problem that confronts the United States over the next 10 years will be how to deal with its debt problem (Casey 1993, Schiller 1994). The course of range management and the future of western ranching could be determined indirectly by the outcome of this issue.

We also believe a sharp downturn could occur in ranch sales after the presidential election in the 1997-99 period due to exhaustion of both demand and credit (Casey 1993, Davidson and Rees-Mogg 1993, Burkett 1995). This in conjunction with low cattle prices has the potential to cause a sharp drop in western ranch values.

## The Future

While large drops in the value of most western grazing lands may occur in the near term, there could be some positive developments for those ranchers who remain in business or who buy at the bottom of the market. Stockmen in the next few years may be forced to recognize that one of their biggest problems is the various cost subsidies provided by the federal government that depress livestock prices (Schiller 1994, Knutson et al. 1995, Holechek and Hess 1995, Merline 1995). The subsidies include government cost sharing for emergency feed in drought, brush control, watering point development, fence, and predator and insect control. The net effect of all these cost subsidies is to increase meat (beef) supplies well beyond what unaltered market forces would bring forth. Research by Workman et al. (1972) indicated that every 1% increase in beef supplies drops prices by about 1.5%. More recent research indicates that drops as great as 3 to 4% can occur for every 1% increase in beef supplies (Knutson et al. 1995).

The cumulative effect of the various cost subsidies on the supply of beef over the past 10 years is not easily determined. However data we have collected from the USDA on emergency feed program payments and range improvement cost sharing indicate they have increased beef supplies by 10% and probably more. This added supply could easily mean 25–35% lower cattle prices compared to those that would exist without the cost subsidies. In addition the recent North American Free Trade Agreement has resulted in increased exports of beef from Mexico to the United States further increasing meat supplies and depressing prices.

Cost subsidies might be justified if the beef industry in the western United States was characterized by rapidly expanding demand relative to supply. Even if this were true, however we predict that supply would quickly respond to demand without cost subsidies. This was true in the 1870s and 1880s when eastern cattlemen produced unprecedented amounts of meat for a rapidly expanding population. This was done without the aid of federal subsidies.

Per capita beef consumption in the USA is declining (Figure 1) (USDA 1994). Many countries such as Argentina and Australia now produce beef at much lower cost than the USA (Holechek et al. 1994). New production technologies will likely cause further decreases in the price of all agricultural commodities including beef as we move into the 21st century (Davidson and Rees-Mogg 1993, Casey 1993, Walker 1995). At the same time health concerns over red meat consumption (Carper 1995) and drops in the price of chicken relative to beef are likely to cause further per capita consumption shifts away from beef (Godfrey and Pope 1990, Holechek et al. 1994).

The federal government could be forced to greatly reduce agricultural and other business subsidies during the next few years (Knutson et al. 1995, Merline 1995).

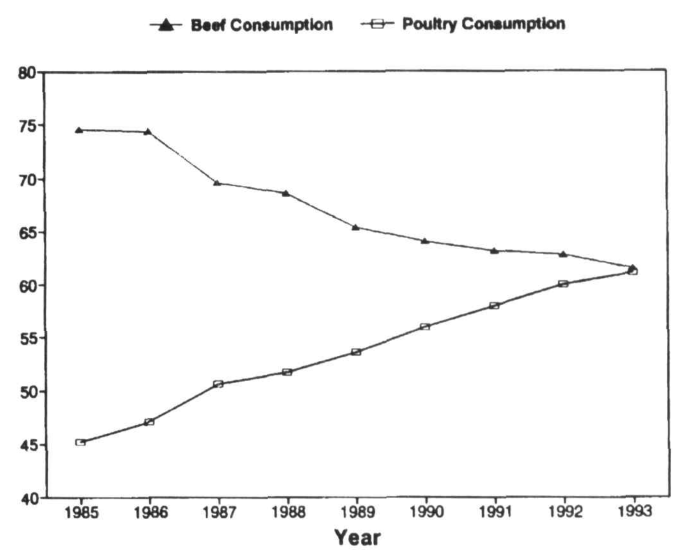


**Fig 1.** *Per capita beef and poultry consumption (lbs/person) in the United States (USDA 1994).*

New Zealand provides a good example of what can happen when government subsidies are removed from agriculture. Since New Zealand scrapped its farm subsidies in 1986, the farm and ranch economy has thrived (Merline 1995). Although the output of some agricultural commodities (beef, mutton, wool) fell immediately after reform due to the end of subsidized over-production, efficiency of production greatly improved. Government officials found that ranchers not only adjusted their output but their management practices also improved. Presently there is not a single farm or ranch organization in the country calling for a return to subsidized farming and ranching. Perhaps most interesting is that New Zealand's free market reforms have resulted in an annual average economic growth rate of 5%, an inflation rate under 2%, and dropping unemployment (Stein 1995). Prior to the 1986 reforms, New Zealand's economy was stagnant and characterized by high inflation, high unemployment, and burgeoning public debt. We believe New Zealand's experience is applicable to the problems and solutions of livestock production on western rangelands.

Without an end to government cost subsidies private western grazing land values could decline to less than 50% of their present value with the exception of those lands that have high development potential. The reason for this is that the cost subsidies which generally create oversupply differentially affect cattle growers in the eastern Great Plains and southern pine forest compared to those in the West. Because their production costs per animal unit are lower, eastern ranchers can remain profitable in an oversupply environment long after western ranches are put out of business by negative profit margins (Holechek and Hawkes 1993). This situation might be avoided if western ranchers are able to diversify into alternative enterprises such as dude ranching, fee hunting, raising exotic animals, or raising plants for xero-scaping that would increase per acre earnings. However it is important to keep in mind that all these enterprises depend on a vibrant, growing economy.

## Conclusion

During 1995 the economy in the United States was in the fourth year of a weak expansion caused in large part by a building boom in the West. Much privately owned western grazing land is priced double or more its value based on earnings from livestock grazing because of future subdivision and other development potential. Grazing lands in the Great Plains appear to be much more reasonably priced relative to earnings potential from livestock than those in the intermountain West. However there is considerable doubt about the future earnings potential of all western grazing land because of a huge imbalance between supply and demand for beef. The environmental movement may be less a threat to western ranchers than the cost subsidies by the federal government. Large numbers of western ranchers could be forced into insolvency during the late 1990s if they are unable to subdivide their land or diversify into other enterprises. However elimination of government cost subsidies in conjunction with application of improved technologies, could again make livestock production profitable on western grazing lands.

## Literature Cited

**Burkett, L. 1995.** The Coming Economic Earthquake. Second Edition. Moody Press, Chicago, Ill.

**Carper, J. 1995.** Stop Aging - Now. Harper-Collins, New York.

**Casey, D. 1993.** Crisis Investing for the Rest of the 90s. Carol Publishing Group, New York.

**Davidson, J. D. and W. Rees-Mogg. 1993.** The Great Reckoning. Simon & Schuster. New York.

**Godfrey, E. B. and C. A. Pope, III. 1990.** The case of removing livestock from public lands. In: Current issues in rangeland resource economics. Oregon State Univ. Ext. Serv. Spec. Rep. 852.

**Holechek, J. L. 1992.** Financial benefits of range management practices in the Chihuahuan desert. Rangelands 14:279–283.

**Holechek, J. L. and K. Hess. 1995.** The Emergency Feed Program. Rangelands 17:133–136.

**Holechek, J. L. and J. Hawkes. 1993.** Desert and prairie ranching profitability. Rangelands 15:104–109.

**Holechek, J. L., J. Hawkes, and T. D. Darden. 1994.** Macro-economics and cattle ranching. Rangelands 16:118–123.

**Knutson, R. D., J. B. Penn, and W. T. Boehm. 1995.** Agricultural and Food Policy. 3rd Edition. Prentice Hall, Inc. Englewood Cliffs, NJ.

**Merline, J. 1995.** Can farming survive markets. Investor's Business Daily. March 9, 1995. p.1-2A.

**Pring, M. J. 1992.** The All-Season Investor. John Wiley & Sons, Inc., New York.

**Schiller, B. R. 1994.** The Economy Today. 6th Edition. McGraw Hill, Inc., New York.

**Stein, R. S. 1995.** New Zealand: Model for reform. Investor's Business Daily, March 16, 1995. p. 1-2A.

**United States Department of Agriculture (USDA). 1994.** Agricultural Statistics. United States Government Printing Office, Washington, D.C.

**Walker, J. W. 1995.** View point: Grazing management and research now and in the next millennium. J. Range Manage. 48:350–358.

**Workman, J. P., S. L. King, and J. F. Hooper. 1972.** Price elasticity of demand for beef and range improvement decisions. J. Range Manage. 25:337–340.

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# Evaluating Grass Development for Grazing Management.

**A. B. Frank**

Management decisions based on plant growth and development can be beneficial to the overall health of the grass stand. Initiation of spring grazing is critical to the season-long vigor and productivity of grasses. Early grazing reduces plant leaf area and photosynthesis which is needed to replace carbohydrates depleted over winter and during greenup. As a consequence plant vigor is reduced, stands are thinned, total forage production is decreased, and disease, insect, and weed infestations are increased. Pastureland and rangeland damaged by early grazing may require several years of rest to regain productivity. On the other hand, late grazing increases forage loss and waste through trampling or reduced palatability and decreased nutritional value.

Grazing readiness or timing has generally been based on calendar date. Beginning grazing based on a calendar date does not take into consideration plant development stage. Decisions based on calendar date may be right some years, but each year is different with respect to beginning of spring; thus, the calendar date method may not coincide with the best time to start grazing. Determining grazing readiness from the development stage of a few key grasses present on the pastureland or rangeland can serve as a guideline for management decisions.

The recommended plant development stage for beginning spring grazing of native and tame cool-season grass species is when the plants are vegetative and have formed 3 to 4 leaves. The events that are important for persistence and vigor in cool-season grasses occur about the time the fourth leaf forms a collar. These events include formation of leaves, tillers, rhizomes, stems, and heads. As the stem elongates at the 4-leaf stage the growing point is elevated and available for grazing. Grazing before stem elongation may result in a stem bearing head devoid of leaves. Grazing before initiation of tillers and rhizomes severely reduces dry matter production and causes weak and thinning grass stands.

The organs of a grass plant develop in an orderly and predictable manner. From a development stage perspective, a new leaf becomes visible on a plant after the one preceding it is almost fully developed. The formation of stems and heads, which contribute significantly to dry matter production, indicate the plant is in the reproductive stages of development. The calendar time at which the first leaf appears and the rate at which each leaf develops is determined by the amount of thermal (heat) energy accumulated during the growth period. The air temperature on any day differs from year to year; therefore, the amount of thermal energy available for plant development on any calendar date—hence development stage—also will vary from year to year.

**Plant Development vs. Growth**

Plant development and growth are processes that contribute to forage grazing readiness, but the two processes are not synonymous. Development refers to formation of plant parts, such as leaves, in an orderly and predictable pattern. Plant growth is the increase in dry weight resulting from the expansion of leaves, stems, and heads. Plant development stage is a phrase used to identify a specified stage of morphological development. There is a positive correlation between development and growth in forage grasses which suggests that grazing readiness can be determined from plant development stage based on the number of leaves formed. Initiating grazing at a specific development stage is predictable and can be repeated each year, whereas initiating grazing at a specific forage yield is not as easily predictable and may be highly variable.

**Development Stage Scales**

Describing the development stage of grasses can easily be accomplished by comparing plant morphology to development stage scales or schemes in the field (Fig. 1). There are scales available that were developed solely for scoring development stages in forage grasses and several that were developed for cereal crops that are also acceptable for use with forage grasses. The similarity in morphological structures between cereals and forage grasses allows for use of common scales for scoring development. Following is a brief description of selected scales that can be used to determine the development stage of perennial grasses. For details on each scale, the original reference citation should be reviewed.

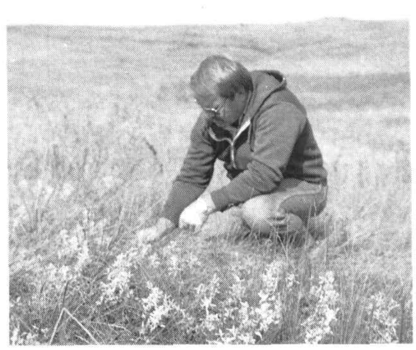

**Fig. 1** *Scoring grasses for morphological development requires field visits.*

### Haun

The Haun scale (1973), originally developed for wheat, is a numerical expression of plant morphological development based on the number of leaves produced on the main stem with additional descriptors for head development. The Haun scale has a high degree of precision in describing leaf insertion rate on the main stem. Plant development referenced to the Haun scale is highly correlated with growing degree-days (GDD), which provides utility for determining development stages through modeling. The Haun scale is simple, easy to use, and provides the basic information for making management decisions.

### Moore

The Moore et al. (1991) scale was developed specifically for forage and range grasses. This scale utilizes a set of morphological descriptors for describing development of grass tillers through five primary development stages of germination, vegetative, elongation, reproduction, and seed ripening. Substages within each primary stage are used to provide sufficient detail to fully describe plant development. The numerical code describing the growth stage is easily memorized for field use and is acceptable for data entry and statistical analysis.

### Sanderson

The Sanderson (1992) scale describes development of warm-season perennial forage grasses. It was developed for use with kleingrass and switchgrass, but is applicable to many other bunchgrasses. It is based on selected aspects of the Haun (1973), Simon and Park (1983), and Hedlund and Höglund (1983) scales. The scale describes 35 separate stages across development of the plant leaves, stems, and reproductive or head structures. The Sanderson scale is complex, providing detail and precision necessary for research applications.

### Simon

The Simon and Park (1983) scale was developed for perennial forage grasses. This scale is based on the Zadoks et al. (1974) scale and like Zadoks uses a 2 digit code to describe the principal development stages for number of leaves, elongation of the sheath, stem elongation, inflorescence emergence, anthesis, and seed ripening. The Simon scale is very detailed and provides a complete description of all phases of plant development. The complexity of this scale makes it best suited for research purposes.

### Zadoks

The Zadoks et al. (1974) scale was developed for cereal crops, but is applicable to all Gramineae. This scale has sufficient detail to describe all phases of plant development. This scale uses a 2-digit code. The first digit identifies the principal development stage and the second digit the secondary development stage. The Zadoks scale uses the ten principal development stages of germination, seedling growth, tillering, stem elongation, booting, inflorescence emergence, anthesis, milk development, dough development, and ripening to describe all phases of plant development. Secondary development stages are used to designate plant development within each of the ten principal development stages.

### Use of Development Stage Information

Development stage information can be used in making management decisions on when to begin grazing initial spring growth and regrowth forage. In more intensively managed grass seed production applications, development staging information can be used to determine timing of herbicide and pesticide applications and harvesting operations. Development stage scales for determining grazing readiness need more detail during the vegetative leaf development period, whereas for seed production, the scales need additional detail from vegetative leaf production through seed ripening stages to be most useful for producers. In understanding plant development and in developing management criteria, it is important that scientists, action agency people, and producers use common terms in describing the development stages of forage crops. Accepting use of the development stage concept should provide a more detailed description of plant development events and be more effective for information transfer activities.

*Air temperature is the main environmental factor that determines the rate of plant development.*

### Calculating Growing Degree-Days

Air temperature is the main environmental factor that determines the rate of plant development. Each leaf produced on a stem requires a specific amount of accumulated thermal energy, or heat units, for development. The temperature when plants initiate development or the base temperature is generally set at 32°F (0°C) for cool-season and about 50°F (10°C) for warm-season grasses. The temperature or accumulated heat units that a plant needs to produce a leaf can be expressed as growing degree-days or GDD. For any calendar day, the number of GDD for that day is the average of the daily hourly minimum and hourly maximum temperature in the same 24-hour period minus the base temperature. The equation for calculation is:

$$GDD = (Tmax + Tmin)/2 - Tbase$$

where GDD = growing degree days,
Tmax = daily maximum temperature,
Tmin = daily minimum temperature,
Tbase = 32°F for cool-season and 50°F for warm-season grasses

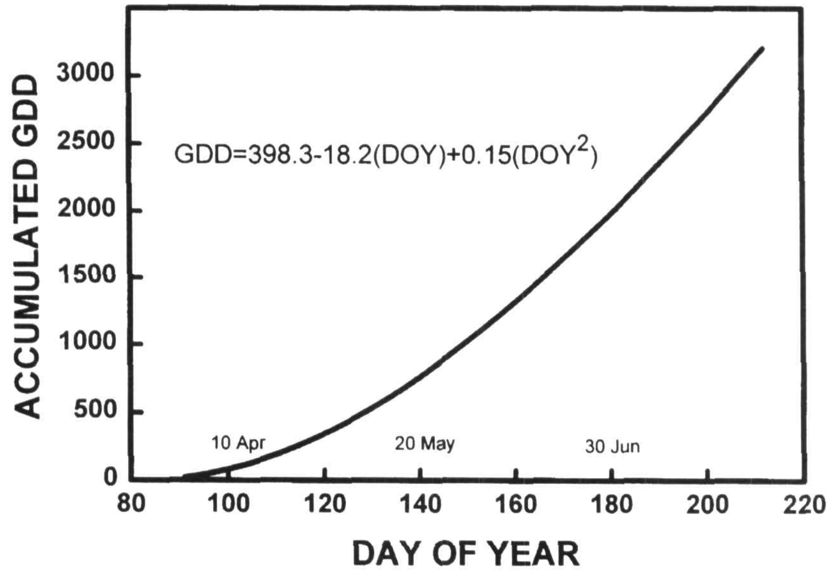


**Fig. 2.** *Accumulated growing degree-days calculated from the average daily minimum and maximum temperatures, using 32° F as the base temperature, for the 1951 to 1980 period at Bismarck, ND.*

### Accumulating Growing Degree-Days

Daily Growing Degree Days (GDD) are summed to determine total GDD accumulated from initiation of spring growth to the current date. As an example, the average number of GDD accumulated at Bismarck, ND from April 1 to July 31 are presented in Fig. 2. The date in early spring to start recording temperatures for calculating GDD to determine development stage of perennial forage grasses is different than for annual forages or new seedings. In new seedings emergence dates are easily determined, but in established stands the time that growth and development begins in the spring is less obvious. Frank et al. (1985) determined that the optimum time to start recording accumulated GDD at Mandan, ND was on the first day after March 15 that the average daily air temperature (daily maximum + daily minimum/2) exceeded 32°F for 5 consecutive days.

### Growing Degree-Days and Grazing Readiness

The recommended development stage for beginning grazing cool-season native and tame pasture grasses is the 3 to 4 leaf stage which coincides closely to Haun stage 3.5 (Fig. 3). The GDD needed to produce each leaf on some tame and native forage grasses as determined from regression analysis of accumulated GDD and growth stage using the Haun scale are shown in Table 1.

Native grasses generally require more GDD than improved grasses to produce a leaf (Frank and Hofmann, 1989; Frank and Ries, 1990). In order to use development stages for determining when to begin grazing, an indicator grass and the stage for beginning grazing should be determined. As an example, green needlegrass will be selected as the indicator grass at a Haun stage of 3.5. Data in Table 1 shows that green needlegrass requires 1209 GDD to reach Haun stage 3.5. It is best to calculate GDD from actual weather data as described earlier, but for this example the GDD and day of year relationship from Fig. 2 is adequate. To determine the date when 1209 GDD were accumulated at Bismarck, ND use either the equation or extrapolate from the regression line in Fig. 2. Either approach will show that by 6 June, 1209 GDD will have been accumulated. Therefore, from this example, using green needlegrass as the key grass on which to base our decision, grazing could start about 6 June. The date when using other native grasses as key grasses to reach Haun stage 3.5 would be needleandthread, 30 May; prairie junegrass, 20 May; and western wheatgrass, 1 June. Blue grama, a warm-season grass, reached Haun stage 3.5 on 30 June.

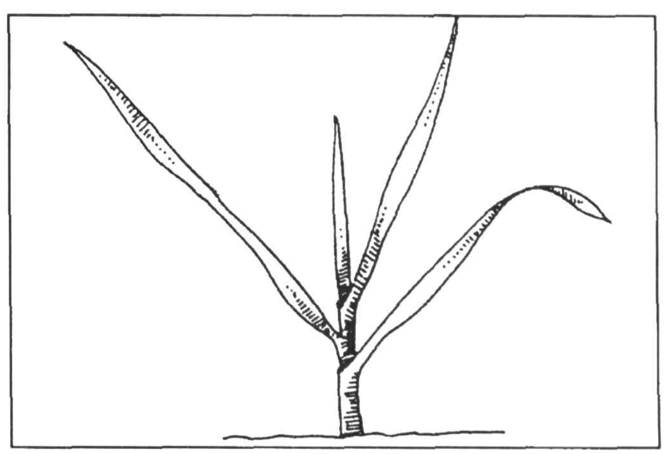

**Fig. 3.** *This grass plant has developed collars on three leaves. The fourth leaf is about one-half as long as the third leaf. The numerical score for scales listed in this paper for this grass plant would be Haun 3.5, Moore V3, Sanderson 3.5, Simon 23, and Zadoks 13.*

**Table 1. Growing degree-days required for some native and improved grasses to develop to Haun stages 1 through 5.**

| | Native Range Grasses in Mixed Prairie Haun Development Stage* | | | | |
|---|---|---|---|---|---|
| Grass | 1 | 2 | 3 | 3.5 | 4 |
| Green Needlegrass | 346 | 691 | 1037 | 1209 | 1382 |
| Needleandthread | 290 | 580 | 869 | 1014 | 1159 |
| Prairie Junegrass | 216 | 432 | 648 | 756 | 864 |
| Western Wheatgrass | 297 | 603 | 954 | 1170 | 1386 |
| Blue Grama | 423 | 711 | 1062 | 1296 | 1530 |
| | Grass Seeded in Pure Stands | | | | |
| Nordan Crested Wheatgrass | 148 | 295 | 443 | 516 | 590 |
| Intermediate Wheatgrass | 225 | 450 | 675 | 787 | 900 |
| Rodan Western Wheatgrass | 178 | 356 | 535 | 624 | 713 |

*A Haun stage of 3.5 is defined as a plant that has 3 fully developed and collared leaves. The fourth leaf, when extended, would be one-half as long as the third leaf. This stage is about equivalent to the 3 leaf stage often recommended for beginning grazing of cool-season grasses.

The tame cool-season grasses require fewer GDD to form a leaf and can generally be grazed earlier than the native grasses or about the 3 leaf stage. Using Fig. 2 and following the same procedures as above, Nordan crested wheatgrass requires 443 GDD to reach Haun stage 3 which occurred on 6 May, intermediate wheatgrass needed 675 GDD (17 May), and seeded Rodan western wheatgrass needed 535 GDD (11 May). The differences observed between native prairie western wheatgrass and seeded Rodan western wheatgrass is due to selection by plant breeders for early development in Rodan.

### Record Keeping

The Growing Degree Day (GDD) method requires the following record keeping to determine plant development stage. (1) Record the daily maximum and minimum temperatures and calculate the daily GDD. Temperatures can usually be obtained from weather reports on the local radio or television station or from newspapers. (2) Determine the starting date for calculating GDD which is the date that the grass begins to develop in the spring, not when the grass starts to turn green , but when the leaf blade begins to elongate. (3) Accumulate the GDD for each day from the starting date determined in step 2. If the daily maximum temperature is less than 32˚F for cool-season and 50˚F for warm-season grasses no GDD are accumulated for that day. (4) Use Table 1 to determine the GDD required for the key species listed to reach Haun stage 3.5. At this stage, these species would be ready for grazing. (5) It is also desirable that one visits the pasture weekly during the active growth period to become familiar with grass development and to verify calculated stages. By counting the number of leaves and determining the development stage, and by making comparisons to the GDD accumulated to that date, producers will better understand grass growth and development and can then make management decisions based on the plants growth condition.

## Conclusions

Using the development staging and the GDD approach to determine grazing readiness will take the guess work out of when grazing can begin on rangeland and pastureland. If grazing is started at the proper development stage, the plants will be more tolerant of grazing stress and will maintain the higher vigor needed to continue forage production during the grazing season and in following years. Since the time of initiation of spring greenup determines the development stage of grasses and thus grazing readiness, the staging approach is more precise than the calendar date method for selecting the proper time to begin grazing.

## Literature Cited

**Frank, A. B., J. D. Berdahl, and R. E. Barker. 1985.** Morphological development and water use in clonal lines of four forage grasses. Crop Sci. 25:339–344.

**Frank, A. B., and L. Hofmann. 1989.** Relationship among grazing management, growing degree-days, and morphological development for native grasses on the northern Great Plains. J. Range Manage. 42:199–202.

**Frank, A. B., and R. E. Ries. 1990.** Effect of soil water and nitrogen on morphological development of crested and western wheatgrass. J. Range Manage. 43:255–258.

**Haun, J. R. 1973.** Visual quantification of wheat development. Agron. J. 65:116–119.

**Hedlund, E. K., and S. Höglund. 1983.** Scheme of development in timothy, red clover, and lucerne. Unpublished M.S. Thesis. The Royal Swedish Agricultural College, Uppsala, Sweden.

**Moore, K. J., L. E. Moser, K. P. Vogel, S. S. Waller, B. E. Johnson, and J. F. Pedersen. 1991.** Describing and quantifying growth stages of perennial forage grasses. Agron. J. 83:1073–1077.

**Sanderson, Matt A. 1992.** Morphological development of switchgrass and kleingrass. Agron. J. 84:415–419.

**Simon, U., and B. H. Park. 1983.** A descriptive scheme for stages of development in perennial forage grasses. p. 416-418. *In*: J. Allan Smith and Virgil W. Hays (eds.) Proc. XIV Int. Grassl. Congr. Westview Press, Boulder, Colo.

**Zadoks, J. C., T. T. Chang, and C. F. Konzak. 1974.** A decimal code for the growth stages of cereals. Weed Res. 14:415–421.

The author is with the USDA, Agricultural Research Service, Northern Great Plains Research Laboratory, P.O. Box 459, Mandan, North Dakota 58554.

# Requiescat in Pace

E. Lavelle Thompson, 84, a resident of Albuquerque since 1964, died March 21, 1996.

Mr. Thompson spent his formative years on ranches in Indian Valley and the South Fork of the Salmon River in Idaho. He completed his high school education at the Intermountain Institute, a boarding school in Weiser, Ida. Mr. Thompson graduated with a Bachelor of Science Degree in Forestry from the University of Idaho in 1938. He accepted employment with the U.S. Forest Service in 1934 and served on numerous assignments in Idaho, Arizona, and New Mexico, including District Ranger on three districts located on two National Forests, Fire Control Staff Officer on the Payette National Forest and Forest Supervisor of the Apache National Forest in Springerville, Ariz. He retired from the Forest Service in 1969 after a career spanning 35 years. Mr. Thompson was active in several civic and fraternal organizations including Kiwanis International, Amigo (retired Forest Service employees), Enchanted Lens Camera Club, Aristocrat Caravaners, and the International Knife and Fork Club. He was also a member of Zia Daylight Lodge #77, A.F. & A.M., and the proud recipient of his 50 year pin.

Mr. Thompson was also a member of the Immanuel Presbyterian Church. He was a charter member of the Society for Range Management where he was actively promoting conservation and the wise use of rangelands. Even after retirement he remained professionally active serving as an advisor to the Forest Service, and the Bureau of Land Management. In addition he was an active member and held leadership positions in the following professional organizations; Albuquerque Wildlife Federation, Conservation Action League, National Wildlife Federation, Society of American Forestry Association, and National Wildlife Refuge Association.

Mr. Thompson is survived by his wife, Rose Thompson of Albuquerque.



## Thru Theo's Window at the Ranch

The Big Belts against the horizon.
Rugged mountains, uneven and blue,
Dark shadowed, mauve and deep purple.
At their base, a silvery hue.

Ever clouds billowing over,
At times, immense, fleecy and white.
Or dark and laden with rainfall,
They thunder along in their flight.

The buttes and rocky formations
Leading down to the arable lands,
Strip-farmed for soil conservation;
Vast fields of black and gold bands.

The following meadow before me
Fast losing its bright summer green,
Where a flock of spring lambs are grazing,
And Square Butte looms, lone and serene.

This beautiful view before me,
A feast for the soul and the eye,
Portrayal of earth's wonderous workings,
And over it all, the Big Sky.

**Hazel M. Thomson**
**1964**

This poem is a contribution from John Mitchell written by his great Aunt Hazel Thomson. Theo was John's grandmother on his mother's side of the family.

# Current Literature

This section has the objective of alerting SRM members and other readers of *Rangelands* of the availability of new, useful literature being published on applied range management. Readers are requested to suggest literature items—and preferably also contribute single copies for review—for including in this section in subsequent issues. Personal copies should be requested from the respective publisher or senior author (address shown in parenthesis for each citation).

**Animal Performance and Fleece Characteristics of Angora Goats Maintained on Western and Southern Texas Rangelands;** by C.J. Lupton, J.E. Huston, J.W. Holloway, B.G. Warrington, et. al.; 1996; J. Anim. Sci. 74(3):545–550. (Texas Agric. Expt. Sta., San Angelo Tex. 76901) "If problems with predation and poisonous plants (guajillo) could be controlled, economic returns from mohair production by castrated Angora goats on the South Texas Plains (less favorable environment) would be similar to those experienced on the Edwards Plateau, despite the substantially different ecosystems."

**Calving Intervals in Beef Cows at 2, 3, and 4 years of Age When Breeding is not Restricted after Calving;** by L.A. Werth, S.M. Azzam, and J.E. Kinder; 1996; J. Anim. Sci. 74(3):593-596. (Dept. Anim. Sci., Univ. Neb., Lincoln, Neb. 68583-0908) Conclusions: If young beef cows are allowed to breed at the first estrus following calving, calving interval will be greater between 2 and 3 than between 3 and 4 years of age but may be less than 365 days even between 2 and 3; beef producers may be able to develop beef herds with cows of greater fertility if young cows were selected on their ability to become pregnant during the early postpartum period.

**Cattle Use of Microclimates on a Northern Latitude Winter Range;** by G.A. Houseal and B.E. Olson; 1995; Can. J. Anim. Sci. 75(4):501–507. (Dept. Anim. & Range Sci., Mon. State Univ., Bozeman, Mon. 59717) "Cattle selected moderate microclimates for grazing as a response to extreme wind and cold. . . .The availability of moderate microclimates in a pasture may allow cows to continue grazing, thus maintaining intake, even when general conditions might otherwise cause them to defer from grazing."

**Dietary Habits and Social Interactions Affect Choice of Feeding Location by Sheep;** by Cody B. Scott, Frederick D. Provenza, and Roger E. Banner; 1995; Appl. Anim. Beh. Sci. 45(3-4):225–237. (Dept. Rangeland Res., Utah State Univ., Logan, Utah 84322-5230) This study was designed to determine how preferences for particular foods influenced use of the environment by subgroups of sheep (these having different dietary habits) and if social factors could override acquired preferences and aversions.

**Digestion of Low Protein Grass Hay by Muskoxen and Cattle;** by Jan Z. Adamczewski, WIlliam M. Kerr, Ewald F. Lammerding, and Peter F. Flood; 1994; J. WIldl. Mgt. 58(4):679–685. (Dept. Vet. Anat., Univ. Sask., Saskatoon, Sask. S7N 0W0) Muskoxen were found well adapted to digesting low quality graminoid forage and maintaining mass at low rates of intake, these traits likely contributing to their success in surviving long arctic winters.

Compiled by John F. Vallentine, Emeritus Professor of Range Science, Brigham Young University, Provo, Utah 84602.

**Dissipation of Glyphosate and Its Metabolite AMPA in Established Crested Wheatgrass Following Spring Application;** by Allan J. Cessna and John Waddington; 1995; Can. J. Plant Sci. 75(3):759–762. (Agric. & Agri-Food Canada, Saskatoon Res. Centre, Saskatoon, Sask. S7N 0X2) Glyphosate residues on crested wheatgrass foliage decreased to acceptable international MRL levels within two weeks of spring application; washoff by rainfall appeared to be the major route of dissipation.

**Economic Analysis of Grazing and Subsequent Feeding of Steers from Three Fescue Pasture Alternatives;** by R.O. Burton, Jr., P.T. Berends, J.L. Moyer, K.P. Coffey, and L.W. Lomas; 1994; J. Prod. Agric. 7(4):482–489. (Dept. Agric. Econ., Kan. State Univ., Manhattan, Kan. 66506) Pasture alternatives in this study were endophyte-infected tall fescue, endophyte-infected tall fescue-ladino clover mixture, and endophyte-free tall fescue.

**Effect of Seed Size on Seedling Vigor and Forage Production of Winter Wheat;** by W.W. Bockus and J.P. Shroyer; 1996; Can. J. Plant Sci. 76(1):101–105. (Dept. Plant Path., Kan. State Univ., Manhattan, Kan. 66506) Conclusions: large seed help reduce soil erosion by producing plants with greater ground cover; large seed sown early also increase amount of forage available for grazing.

**Effect of Wheat Morphological Stage at Grazing Termination on Economic Return;** by Larry A. Redmon, Eugene G. Krenzer, Jr., Daniel J. Bernardo, and Gerald W. Horn; 1996; Agron. J. 88(1):94–97. (Dept. Agron., Okla. State Univ., Stillwater, Okla. 74078) Net return was maximized when grazing was terminated at first hollow stem. Grazing beyond this point decreased grain yield, and the extra weight gain by cattle was not sufficient to offset grain yield losses.

**Effects of Tall Wheatgrass Windbreaks on Hay Production of Three Alfalfa Varieties at a Semiarid Location in Saskatchewan;** by J. Waddington and H. Steppuhn; 1995; Can. J. Plant Sci. 75(4):877–881. (Research Centre, Agric. & Agri-Food Canada, Swift Current, Sask. S9H 3X2) Alfalfa grown between tall wheatgrass windbreaks produced about 45% more dry matter than when grown without windbreaks; this benefit resulted from the extra water gained by snow management and the reduced evapotranspiration resullting from wind reduction by the tall wheatgrass windbreaks.

**Frost-Seeding Legumes into Established Switchgrass: Establishment, Density, Persistence, and Sward Composition;** by Randall M. Gettle, J. Ronald George, Kevin M. Blanchet, Dwayne R. Buxton, and Kenneth J. Moore; 1996; Agron. J. 88(1):98–103. (USDA-ARS, Field Crops Res. Unit, Iowa State Univ., Ames, Iowa 50011) Legumes were successfully introduced by this method into established switchgrass; red clover, birdsfoot trefoil, and their mixture were more competitive than alfalfa with the switchgrass but not considered serious.

**Genetic Structure and Gene Flow in *Elymus glaucus* (Blue Wildrye): Implications for Native Grassland Restoration;** by Eric E. Knapp and Kevin J. Rice; 1996; Restor. Ecol. 4(1):1–10. (Dept. Agron. & Range Sci., Univ. Calif., Davis, Calif. 95616-8515) The purpose of the study was to investigate the genetic structure of blue wildrye in populations collected over a broad geographic area and to make recommendations for the transfer and use of seed in revegetation and restoration projects.

**Genetic Trend and Environmental Effects in a Population of Cattle Selected for Twinning;** by L.D. Van Vleck and K.E. Gregory; 1996; J. Anim. Sci. 74(3):522–528. (USDA-ARS, Meat Animal Res. Center, Clay Center, Neb. 68933-0166) Twinning has relatively low heritability in cattle; but twinning rate was raised to 15% during the 12 years of selection; this is an approximate 10-fold increase.

**Grazing Management Affects Manure Distribution by Beef Cattle;** by P.R. Peterson and J.R. Gerrish; 1995; Amer. For. & Grassland Counc. Proc. 1995:170–174. (Plant Sci. Dept., Macdonald Campus of McGill Univ., Ste-Anne-de-Bellevue, Quebec H9X 3V9) Grazing cells with frequent rotations and minimal landscape variation within individual paddocks resulted in the most uniform manure distribution over the entire paddock.

**Improved Forage Production Following Western Snowberry (*Symphoricarpos occidentalis* Hook.) Control with Metsulfuron Methyl;** by G.G. Bowes and D.T. Spurr; 1995; Can. J. Plant Sci. 75(4):935–940. (Research Sta., Agric. & Agri-Food Canada, Saskatoon, Sask. S7N 0X2) Metsulfuron applied at 15 g/ha controlled western snowberry for at least 6 years, this treatment being more effective than treatment solely with 2,4-D.

**The Influence of Energy Supplementation on Performance, Digestive Kinetics, and Intake of Cattle Grazing Native Flood Meadows in Eastern Oregon;** by Ray Angell, Roxane Barton, and Tim DelCurto; 1995; Amer. Soc. Anim. Sci., West. Sect. Proc. 46:475–478. (USDA-ARS, Eastern Ore. Agric. Res. Center, Burns, Ore 97720) Low levels of energy supplementation did not enhance average daily gains of young growing animals spring grazing high quality native flood meadows enough to warrant the extra labor and expense involved.

**Influence of Processing Supplemental Alfalfa on Intake and Digestion of Dormant Bluestem-Range Forage by Steers;** by B.A. Lintzenich, E.S. Vanzant, R.C. Cochran, J.L. Beaty, et al.; 1995; J. Animal. Sci. 73(4):1187–1195. (Dept. Anim. Sci. & Ind., Kansas State Univ., Manhattan, Kan. 66506) Supplemental alfalfa dramatically improved the utilization of the low-quality range forage; but method of processing the high-quality alfalfa used did not significantly alter intake or digestion response.

**Lack of Maternal Influence on Lamb Consumption of Locoweed *(Oxytropis sericea)*;** by James A. Pfister and Kermit W. Price; 1996; J. Anim. Sci. 74(2):340–344. (USDA-ARS, Poisonous Plant Res. Lab., Logan, Utah 84321) Short-term maternal influence was not sufficient to condition a preference for locoweed in lambs; it was conjectured that long-term, repeated exposure with the mother, and perhaps peer influences, may be necessary to condition such a preference in lambs.

**Livestock Production Potential on Irrigated Utah Intermountain Meadows;** by R.C. Rollim, K.C. Olson, B.R. Bowman, and H.Q. Winger; 1995; Amer. Soc. Anim. Sci., West. Sect. Proc. 46:335–338. (Dept. Anim., Dairy, & Vet. Sci., Utah State Univ., Logan, Utah 84322) Objectives of the study were (1) to determine the proper stocking rate for cow/calf spring-summer grazing operations, (2) determine forage intake by cows, (3) determine nutrient quality of cattle diets, and (4) quantify forage availability. Diet quality, calf production, and cow body condition were all reduced by higher stocking rates.

**The Need for Consideration of Fire Behavior and Effects in Prescribed Burning;** by E.A. Johnson and K. Miyanishi; 1995; Restor. Ecol. 3(4):271–278. (Dept. Biol. Sci., Univ. Calgary, Calgary, Alta. T2N 1N4) Discusses the processes of heat transfer and the relative role of various fuel variables in these processes, as well as the concepts of fire intensity, rate of spread, fuel consumption, duff consumption, fire frequency, and the ecological effects associated with variation in these characteristics of fire behavior.

**Seed Longevity of 41 Weed Species Buried 17 Years in Eastern and Western Nebraska;** by Orvin C. Burnside, Robert G. Wilson, Sanford Weisberg, and Kenneth G. Hubbard; 1996; Weed Sci. 44(1):74–86. (Dept. Agron. & Plant Genetics, Univ. Minn., St. Paul, Minn. 55108) Selected examples of germination of seed buried in sandy loam soil in western Nebraska (20 cm. depth): (1) cheatgrass after burial for one year, 1%; (2) kochia after two years, 2%, (3) Russian thistle after two years, 1%; (4) musk thistle after 5 years, 38%, after 9 years, 4%; (5) Canada thistle after 12 years, 17%; and (6) jimsonweed after 17 years, 90%.

**Storage Method Effects on Dry Matter and Quality Losses of Tall Fescue Round Bales;** by M. Collins, L.D. Swetnam, G.M. Turner, J.N. Hancock, and S.A. Shearer; 1995; Agron. J. 87(4):507–514. (Univ. Ky., N222E Agric. Sci. Center, Lexington, Ky. 40546-0091) Evaluated the utility of solid plastic wrap and plastic mesh wrap binding materials in reducing yield and quality losses of tall fescue round bales during outside storage.

**Strategies for Mixed-Grass Prairie Restoration: Herbicide, Tilling, and Nitrogen Manipulation;** by Scott D. Wilson and Ann K. Gerry; 1995; Restor. Ecol. 3(4):290–298. (Dept. Biol., Univ. Regina, Regina, Sask. S4S 0A2) This study was directed at the suppression of crested wheatgrass and smooth brome and their replacement by native grasses. The responses found in the study emphasize the importance of neighbor-free establishment sites as a prerequisite for prairie "restoration" in establishing native grasses.

**Using Remote Sensing for Detecting and Mapping Noxious Plants;** by J.H. Everitt, D.E. Escobar, and M.R. Davis; 1995; Weed Abstracts 44(12):639–649. (USDA-ARS, Remote Sensing Res. Unit, 2413 E. Highway 83, Weslaco, Tex. 78596) A review paper that presents an overview on the application of aerial photography, airborne videography, and satellite sensor imagery for detecting brush and weed species on rangelands in Southern USA.

**Yield and Botanical Composition of Legume-Interseeded vs. Nitrogen-Fertilized Switchgrass;** by J. Ronald George, Kevin M. Blanchet, Randall M. Gettle, Dwayne R. Buxton, and Kenneth J. Moore; 1995; Agron. J. 87(6):1147–1153. (USDA-ARS, Iowa State Univ., Ames, Iowa 50011) Evaluated cool-season legume renovation of established switchgrass by comparing forage yield and botanical composition for interseeded legumes versus N fertilized switchgrass.

**Rangelands** is seeking a volunteer to coordinate the Current Literature Section. John Valentine, who has had the position for many years, will be retiring at the end of this year.

**Please Contact:**
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# Grazing the Hill

**Vivan M. Jennings**
**Washington Representative**

**The 1996 Farm Bill - Will FAIR be fair?** The 1996 Farm Bill, is now reality. It was a taxing evolutionary process for the enabling authorization bill to make it through the legislative process. It is now known officially as the 1996 Federal Agricultural Improvement and Reform Act (FAIR), but to those linked with it, it will be called the 1996 Farm Bill.

After experiencing this long drawn out process leading to FAIR, I'm reminded of the old saying that goes something like this; "You usually don't know what it is you really want, until you see something better than what you already have". I suspect the saying reflects the feelings many people have about the new FAIR Act. Under the market transition component, often referred to as the Freedom to Farm section of the Act, there will be dramatic differences facing agricultural producers who have become acclimated to safety net provisions provided by deficiency payments for certain crops. Under the commodity title, farmers will like the part that allows them the freedom to plant whatever crops they chose and how much land they can use. Producers will now have to pay more attention to market conditions, production costs and price volatility. Although these factors will directly impact selected crop producers and in particular small farmers and rural communities, it will have a ripple effect on most everyone else in agriculture as well as the public. Many will start asking if FAIR is fair to all involved by the legislation. Price stability and inflationary concerns may result in Congress wanting to revisit farm and ranch legislation again in the future.

On April 17 th Paul Johnson, Chief, Natural Resources Conservation Service (NRCS) told the National Grazing Lands Conservation Initiative (GLCI) Steering Committee that "The new Farm Bill is not only a market transition bill, but, it is an environmental stewardship transition bill". That went over well with the GLCI group, as well as others, that want to support environmental causes privately and through voluntary programs implemented at the local level.

I think most conservationists would agree with Paul Johnson. The new act contains many positive conservation provisions and shows a commitment to environmental protection by the agricultural community and the public according to Norm Berg, past Chief of the Soil Conservation Service, now NRCS. The Act extends the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) and of great interest to private grazing lands supporters, provides authorization for new initiatives on private lands. More than $2.5 billion in new funding is identified with conservation provisions in the new language.

### Grazing Lands Conservation Initiative (GLCI) Update

It didn't take long for the GLCI Steering Committee to initiate action after the Conservation of Private Grazing Land (CPGL) Program was authorized under Sec. 386, Title III - Conservation of FAIR. Chairman John Roberts, a dairyman from Vermont, called for a meeting of the Committee on April 16-18, 1996 in Washington D.C. with 15 of the 18 members attended. The purpose of the meeting was to focus on better understanding the CPGL program and to garner support for appropriation of funds to initiate action toward programmatic goals.

Some unique features of CPGL are:

1) Private grazing land constitute nearly 1/2 of the non-Federal land if the United States and is basic to the environment , social and economic stability of rural communities. Private grazing land contain a complex set of interactions among soil, water, air, plants, and animals.

2) Grazing land constitutes the single largest watershed cover type in the United States.

3) Private grazing land constitutes the most extensive wildlife habitat in the United States. About 70% of wildlife is on private land and nearly 78% of endangered species are located there.

4) Private grazing land can provide opportunities for improved nutrient management programs.

5) Owners and managers of private grazing land need to continue to recognize conservation problems when they arise and need technical assistance to assist in problem solving.

6) New science and technology from research and extension must continually be made available so owners and managers may make informed decisions concerning vital grazing land resources.

7) Resources of USDA agencies need to be made available to provide technical assistance, research and education to owners and managers of private grazing land to ensure long-term productivity and ecological health of grazing land.

8) Voluntary cooperation through local partnerships between private interests and local, state and Federal public sector agencies is a must to fulfill the goals of the program.

9) The purpose of CPGL is to provide a coordinated technical, educational, and related assistance program to conserve and enhance private grazing land resources and provide related benefits to all citizens of the United States.

The next step on the part of the private sector leaders involved is to assist with focusing attention on needed appropriation of funds. This will be a tough task considering down sizing and fiscal constraints facing new initiatives. However, this is not an impossible task when there is a coalition of interested private sector stakeholders willing to donate time and resources to make it happen. Twenty million dollars is authorized for fiscal year 1996, followed by $40 million for fiscal year 1997 and $60 million for fiscal year 1998 and each subsequent fiscal year.

At the GLCI Steering Committee meeting , expansion of public sector advisors to the Committee was accepted. Now included, in addition to representatives from NRCS, are representatives from the Agricultural Research Service (ARS), Cooperative States Research, Education, and Extension Service (CSREES), the Extension Committee on Organization and Policy (ECOP), and the Experiment Station Committee on Organization and policy (ESCOP). This expansion will link these agencies to the second phase of the initiative linked to research and education.

An initiative like GLCI, now the CPGL program, doesn't happen without dedicated involvement by individuals who methodically plan what needs to happen and then sees that it does happen. Gary Westmoreland, National Coordinator for GLCI has been the individual from the beginning that has worked closely with the Steering Committee as they have chartered the course. Gary has also been the one to provide leadership to organize state coalitions focused on GLCI in at least 43 states.

**Deen Boe Retires**

Friends and associates wish Deen Boe a well deserved retirement as he leaves his current position as Deputy Director of Range Management, U.S. Forest Service on May 3, 1996. Deen has had a long illustrious career. He served as Forest Supervisor on the Nebraska National Forest, District Ranger on two ranger districts, Group Leader for Range Management in the Eastern Region and a variety of resource management positions in 3 of the 9 regions of the agency. Deen also served as staff assistant on what is now the Forests and Public Lands Subcommittee of Energy and Natural Resources Committee of the U.S. Senate and as a Senior Fellow with the National Governor's Association. Deen has been active as an SRM member and Director.

Deen and his wife Kathy will be establishing themselves later in the year in the Shenandoah Valley. We wish them well.

**Invasive Weed Awareness Coalition Activity (IWAC)**

IWAC met recently to lay out strategy for increasing the awareness of noxious and invasive weed problems for the public and interested decision makers. Linkages of IWAC to the Grazing Land Conservation Initiative were discussed and plans were made to hold a summer weed tour for interested participants and decision makers. Plans for the weed tour will be finalized soon.

**Federal Interagency Committee for the Management of Noxious and Exotic Weeds**

Deb Hayes, U.S. Forest Service and Sean Furniss, U.S. Fish and Wildlife Service are Co-chairs of the Federal Interagency Committee for the Management of Noxious and Exotic Weeds. The Committee met in Washington D.C. April 30 to review a draft national strategy, look at short and long term priorities, and to determine how linkages with the Sharing Common Ground program might be established.

# Board of Directors Meeting Highlights

The Annual Meeting of the SRM Board of Directors was held in the Plaza Room of the Broadview Grand Heritage in Wichita, Kansas on February 10–15, 1996. President Fred C. Bryant presided.

The 1996 Operating Budget was approved by the Board.

The Board praised the Research Affairs Committee's work on the Research Needs document recently published in *Rangelands*.

The Board was informed that a rangeland assessment survey will go out in the April issue of *Rangelands*. Results may be available by the Summer Meeting in San Antonio.

The Board wishes to urge all Charter members of the Society to attend the 50th Anniversary to be held in Rapid City, S.D. next year. A 50th anniversary pin will be given to all Charter members in attendance.

The Board approved a proposal to publish *Journal of Range Management* abstract in Spanish for a one-year trial basis.

The Ad Hoc Electronic Media Committee (subcommittee of Technology Transfer Committee, recommended that SRM establish a World Wide Web (WWW) site from which information could be made available to computer users located nationally and internationally. Texas A&M University has offered the services of their site to SRM.

The Board approved an expenditure of $300 to get the site up and running.

The National Agricultural Library (NAL) presented a proposal to have the *Journal of Range Management* scanned to CD-ROM and made available on the WWW through a web site at the University of Arizona. The University will provide all scanning and the Society would pay for the CD's only. The NAL is cooperating with the University of Arizona on an experimental project called Agricultural Network Information Center (AgNIC). The Board urged Bud Rumburg to continue his negotiations with the NAL and the University of Arizona.

A recommendation for financial support of the 1996 National Envirothon was presented and the Board approved a contribution in the amount of $100.

The issue of overgrazing in Yellowstone National Park was again discussed. The Board agreed that a letter of concern will be drafted to the park's superintendance.

The Board approved reaccreditation of the undergraduate program at Texas Tech University.

The Leadership Development Committee will be presenting a Leadership Training program for the Board at the Summer Meeting in San Antonio. Jamie Kaestner from National Cattlemen's Association will facilitate the training. The Committee is also developing training for the general membership which will be held at the 1997 Annual Meeting in Rapid City.

The following Board representative assignments were made to Clusters:Business Affairs Cluster–John Buckhouse/Bud Rumburg; Communications Cluster–Jim O'Rourke/Rod Heitschmidt; External Affairs Cluster–John Hunter; Internal Affairs Cluster–Meg Smith/Ron Sosebee; Operations Cluster–Tom Bartlett; Science & Technology Cluster–Linda Hardesty/Lamar Smith.

The Board approved new Policy and Position Statements on Livestock Grazing on Rangelands developed by the Committee.

# Joint Meeting of the Board of Directors and Advisory Council

The following recommendations were made to the SRM Board of Directors at a Joint Meeting with the Advisory Council on February 12, 1996. Advisory Council Chair Bob Childress and President Fred C. Bryant presided. Childress presented the recommendations of the Advisory Council as listed below and the subsequent actions were taken by the Board to the recommendations:

**Recommendation 1.** The Advisory Council recommends that all Section rebates be set at $5.00. The SRM Board of Directors cannot set Section dues. A letter will be written to all Sections urging them to change their regular members dues to $5.00.

**Recommendation 2.** The Advisory Council recommends that an option be available to members to select one journal with their membership and if they wish to receive the other journal, they can purchase it at a set price (either *JRM* or *Rangelands*). The Board approved providing Rangelands with membership with the option of receiving the *Journal of Range Management* for an additional $15.

**Recommendation 3**. The Advisory Council recommends that the Board of Directors accept the California Section's bid to host the 2001 Annual Meeting in Honolulu, Hawaii. The Board accepted the bid from the California Section to host the 2001 Annual Meeting.

**Recommendation 4.** The Advisory Council recommends that the Board of Directors accept a graduated dues increase of $5-$10-$15. The SRM Board approved a dues increase for Regular and First Family members based on annual income. Members with income of less than $40,000 will have a $5 increase, $40,000-$60,000 will have an increase of $10 and over $60,000, a $20 increase.

**Recommendation 5.** The Advisory Council recommends that the Board take action to allow Federal employees to make payroll deduction for dues. The Board may need to look at: 1) a Bylaws change of annual audits, 2) evaluate the number of participants, and 3) a flat rate fee. No action.

## Advisory Council Meeting Highlights

The Advisory Council, Wichita, Kansas, February 11–15, 1996

◆ It was agreed that each section would contribute $50.00 to fund SRM award jackets for the National Land, Pasture and Range Judging Contest held in Oklahoma City each year.

◆ The Advisory Council agreed that all section dues would be $5.00.

◆ The Advisory Council concurred with the proposal from the BOD that each member will get only one journal (*JRM* or *Rangeland*) with their membership. They may receive the other journal if they choose for a separate charge.

◆ South Dakota Section will be raffling and auctioning two commemorative Winchester SRM rifles at the '97 meeting. Copies of these rifles are available to other sections for fund raising.

◆ The 2001 Annual Meeting site–there were no formal bids for 2001 meeting. Then California offered to host the meeting in Honolulu. The California Section will present a formal bid at the '96 summer meeting in San Antonio.

◆ The Advisory Council recommended that the Board of DIrectors increased dues $5, $10, or $15 based on income as voluntarily declared by members.

◆ **Mark Pater,** Arizona Section, was elected Chair-elect of the Advisory Council for 1996.

## Associate Editor Nominations
## *Journal of Range Management*

Replacements are needed for Associate Editors of the *Journal of Range Management* retiring from the Editorial Board in February 1997. We are seeking nominees with expertise in the following general areas: animal ecology, animal physiology, plant animal interactions, grazing management, plant physiology, plant ecology, improvements, reclamation, and measurement/sampling.

Associate Editors serve for 2 years with an optional 2 additional years with the concurrence of the Editor, *JRM*. To nominate a candidate for this important and demanding position, ascertain that the individual is available and willing to serve and then send a letter of nomination to the Editor describing the nominee's qualifications. Interested individuals may nominate themselves. The candidate will be asked to supply a list of publications and an account of experience in reviewing manuscripts.

Send nominations by **1 Aug. 1996** to: Gary Frasier, Editor, *Journal of Range Management,* 7820 Stag Hollow Road, Loveland, Colorado 80537.

# Frasier's Philosophy

Most readers are aware that the journals of the Society, *Rangelands* and the *Journal of Range Management*, along with *Trailboss News* are the one item(s) that all members receive as part of their dues. The 2 journals, *Rangelands* and *JRM*, are published to provide information to SRM members and outside readers. While the readership of the journals is very diverse we strive to provide the types of publication the membership desires. To meet these desires we are continually looking for input on ways to improve the publications.

Every year each SRM committee prepares a Plan of Action to guide their activities for the coming year. Following are the Action Plans for *Rangelands* and the *Journal of Range Management* that were developed during and following the 1996 Annual SRM Meeting in Wichita, Kansas.

*RANGELANDS*

1. To conduct the review and oversee the revision of non-technical articles to be published in *Rangelands.*

2. To publish 6 issues of *Rangelands* in 1996 as required to do so by the SRM By-Laws.

3. To expand the scope of *Rangelands* by inviting authors to prepare paper on subjects such as: Threatened and Endangered Species; Riparian; Water Quality; Animal Waste, Biodiversity; Current Research/Conservation Issues; etc.

4. To evaluate techniques for proviaing guidance to authors writing for *Rangelands* such as "Writing Workshops" at Annual Meetings.

5. To investigate and evaluate means of widening the scope of Rangelands for both internal (SRM members) and external readers.

6. To develop a "Style Manual" for *Rangelands.*

7. To investigate the advisability of initiating and interactive column in *Rangelands* for readers questions.

8. To investigate means of making *Rangelands* more attractive (layout, paper quality, etc) for the readers.

*JOURNAL OF RANGE MANAGEMENT*

1. To conduct the review and oversee the revision of technical articles to be published in the *Journal of Range Management.*

2. To publish 6 issues of the *Journal of Range Management* in 1996 as required to do so by the SRM By-Laws.

3. To investigate the feasibility of having "invited subject" papers on subjects such as: CRP; Threatened and Endangered Species; Riparian, Water Quality; Animal Waste; Biodiversity; Current Research/Conservation Issues; etc. These papers would be in less detail than the current Invited Synthesis paper.

4. To investigate and evaluate various means of improving the *Journal* for both the internal (SRM members) and external readers.

5. To implement for a 1 year test period the publishing of a Spanish translation of the Abstract of each paper published in the *Journal of Range Management.*

6. To investigate (in cooperation/coordination with other interested SRM committees) the feasibility, problems and approaches of electronic media preparation and dissemination of SRM journals, publications, etc.

The editorial board of each publication would welcome comment and suggestions concerning the above Action Plans. Please send any comment, suggestions, ideas, etc. you have to: **Gary Frasier, Editor, 7820 Stag Hollow Road, Loveland, Colorado 80538., FAX 970-482-2909, or E-Mail gfrasier@lamar.colostate.edu.**

I found the following saying.

*Spider's webs in the garden are thicker if early fall is comin.*

I don't know if there is any truth in it. Maybe someone could get a grant to study it. (Did you ever stop to think how some of the old sayings got started).

# Meet Vivan M. Jennings
# Washington Representative
# The Society for Range Management

The Society for Range Management (SRM) is a highly respected professional society dedicated to the proper care of rangeland resources according to Vivan M. Jennings, Washington Representative of the Society for Range Management. Improving the scientific knowledge base of range ecosystem production and management and helping to create an improved public appreciation of desired societal outcomes obtained from a well managed range environment are important objectives of the society, Jennings states.

The position of Washington Representative serves as an extension of the Executive Vice President of SRM, says Jennings. Since SRM is a nonprofit association, it is recognized as a scientific and educational organization under the provisions of Section 501 (c) (3) of the Internal Revenue Code. This provides a framework for how SRM works and is important in how the Society performs its functions. The Washington Representative is an information provider and does not engage in any type of lobbying fuctions, Jennings says.

Most SRM members are familiar with the Washington Representative by way of the bi-monthly article, "Grazing the Hill" published in *Rangelands*. The article is a news article addressing changes taking place in the federal government that may impact the conservation and management of rangeland resources, the Society and the profession of range management. According to Jennings, the article conveys both sides of emerging and current issues on the public agenda.

Since the Washington Representative represents the Society in Washington D.C., another key function of the position is to liaison and attend meetings of other conservation and professional organizations, industrial and commodity organizations and societies, congressional hearings and meetings sponsored by cooperating agencies in the Departments of Agriculture and Interior. These would include the Natural Resources Conservation Service, the Forest Service, Agricultural Research Service and the Bureau of Land Management, Department of Indian Affairs and other agencies such as the Environmental Protection Agency. Jennings says, SRM needs to be kept abreast of agency and organizational activities so that courses of action on policy can be brought to the attention of the Board of Directors. Among other responsibilities the Washington Representative has is to represent SRM on the Board of Directors of the Renewable Natural Resources Foundation (RNRF) and to represent the Society with the Natural Resources Council of America (NRCA). Recently, Jennings served on the RNRF committee to plan the 1996 Leadership Summit for professional society leaders in the natural resources professions. The topic of the summit to be held June 13–14 will be "Working Towards a Sustainable Future" and will link to the "Report on the President's Council on Sustainable Development."

At the recent SRM meetings in Wichita, Jennings presented a concept paper at the request of then SRM President, Fred Bryant, on a certification program to potentially certify grazing land ecosystem practitioners. This would be a similar program focused on grazing land to one now being offered to Certified Crop Advisors (CCA). Presently, about 15,000 individuals have taken the exam to be CCA certified. Certified individuals, would be knowledgeable across broad based standards needed to fulfill the objectives of the program, Jennings stated.

The Washington Representative, is a part time responsibility for Jennings who has other business responsibilities in addition to SRM. It represents less than 20% of a full time position and requires flexibility in scheduling to accommodate the demands. Sometimes my schedule will be full time for three or four days a week and at other times it will be only one day, Jennings says. I always enjoy hearing from SRM members and related contacts. I try to schedule in priority events and activities where I can, stated Jennings.

"Meet Vivan Jennings" was submitted by Bertha C. Gillam, Director of Range Management, Washington, D.C. She is a member of the Professional Affairs Committee.

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