Center for Grassland Studies

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Use of Prescribed Fire in Grassland Management

by James Stubbendieck and Robert Masters, Department of Agronomy, University of Nebraska-Lincoln

Vegetation on the Great Plains 10,000 to 12,000 years ago was much different than that observed by Lewis and Clark. Shrubs and trees were more abundant before the plains region was occupied by the first Americans. The reason for the difference was change in fire. Fire was always a natural part of the ecosystem—interacting with grazing animals and climate to form and maintain grasslands. Before the region was occupied by the American Indians, fires were caused by lightening and were largely restricted to the growing season. Fires were usually small and less intense as they consumed the relatively wet growing plant material, along with the dead organic matter from the previous year. Woody plants flourished in the prairies. The Indians observed that bison and other grazing animals were attracted to the lush regrowth after fires. So they lit fires—changing the fire regime, because these fires were not restricted to the growing season. Dormant-season fires were intense and swept across tens of thousands of acres. While the grasses and forbs could withstand the new fire regime, many of the woody species could not. Therefore, most pre-settlement landscapes and vegetation were not "natural" but were a result of human activity.

When Europeans came to the Great Plains, they brought with them attitudes toward fire that were formed in densely populated Europe or the eastern U. S. To them, fire was a scourge that destroyed property, bared the soil, and sometimes killed. With such a tradition, fire was not used commonly as a land-management tool. It is now widely recognized that some productivity losses of Great Plains grasslands were because of fire suppression.

Benefits of Prescribed Fire

Prescribed fire is not a "magic bullet" that alone will erase past poor management. However, it can yield many benefits if it is used in conjunction with other sound management practices. Prescribed fire in grasslands can: increase grass nutritive quality, palatability, availability, and yield; reduce hazardous fuels; suppress unwanted plants; and improve wildlife habitat. More information on use of fire on Nebraska grasslands can be found in Extension Circular EC 98-148, *Grassland Management With Prescribed Fire.*

When Not to Burn

The use of prescribed fire on sandy soils during the wrong environmental conditions or at the wrong time can be dangerous and fail to achieve management objectives. Fire should be used with caution on sandy soils because wind erosion is possible when ground cover is removed. Although these sites burned in pre-settlement times, the deliberate use of fire on them is not well researched, and management risks are great.

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Policy Advisory Committee Members

The Center for Grassland Studies is a unit within the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources. It receives guidance from a Policy Advisory Committee and a 50-member Citizens Advisory Council. This newsletter is published quarterly.

Martin A. Massengale ..... CGS Director
Pam Murray ..... CGS Coordinator
Jan Shamburg ..... CGS Secretary
Anne Moore ..... Newsletter Layout

From the Director

Having been in Washington more than once this spring, one hears much about support for research and education. Since 2000 is an election year, we will hear considerably more about these topics over the next several months. Research and education are important components to the continued success of our highly technological society today.

We, as a nation, are propelled more each year by information obtained through research and education and the adoption of technology based on that information. One only has to look at the tremendous advances made in agriculture, medicine and other areas to see the impact.

Likewise, you can see the tremendous changes that are occurring in both commerce and industry through the transfer of information stemming from technological advances based on scientific investigations conducted years ago. Methods of doing business today are changing ever so much more rapidly than they have in years past. You might be surprised to know the volume of trade occurring now by way of E-commerce.

Through research and education in agriculture, we have been able to increase the quality and quantities of our commodities (both plants and animals), improve our lawns and other turf areas, make better use of our natural resources, improve nutrition, develop bio-based products, improve our environment, and enhance the quality of our personal lives. All of these areas are important to the subjects with which we deal within the Center for Grassland Studies.

Fewer people are engaged in production agriculture today than in the past. Today, less than 2% of the U.S. population is involved in production agriculture. However, agriculture provides 13.2% of the nation's gross national product, and receives only slightly more than 2% of the federal research and development budget. If the U.S. wishes to remain in the forefront in agricultural production, then it urgently needs to invest more of its gross national product in research and education for this industry.

Research and education are expensive because personnel and operating costs continue to increase, but they are still relatively inexpensive for the return on this investment. For example, most studies indicate that agricultural research has an annual rate of return that varies from 50 to 70%. Our nation has made few other investments over its lifetime where the returns have been as great as they have been for agricultural research and education. Surely, we must continue and increase these investments as we look to the future.

M. A. Massengale

Act Now to Adjust for Drought

by Bruce Anderson, Department of Agronomy, University of Nebraska-Lincoln

It's never too early to prepare for drought, and this year most of Nebraska is in a drought. Despite some March snow and rain, almost all subsoils are very deficient in moisture for this summer's forage crops. This means that with *average* rainfall, carrying capacity of most pastures and rangeland will be 20 to 30% less than normal. Long-term weather forecasts predict *less* than average rainfall, so season-long carrying capacity may be even lower this summer.

Drought forces forage/livestock producers to develop a strategy that deals with indirect economic and biological effects of too many animals for the available feed, as well as direct effects of low water supply on plants and animals. This strategy can be subdivided into three basic categories: 1) livestock inventory; 2) efficient use of existing forage resources; and 3) developing alternative forage supplies.

Adjusting livestock inventory to reduce and balance total forage requirements with available supply usually is the best and most economical alternative. Trying to feed your way through a drought can be financial suicide, especially if the drought lasts more than one growing season. Very few cattle have enough production value to pay for year-round purchased feed. Many strategies can be used to reduce forage demand. They include:

1. Heavily cull late calving cows, older cattle, and less productive cows. Cull early to avoid desperation selling when prices are low.
2. Remove yearlings from pasture early—sell or drylot.
3. Early wean—more effective than creep feeding. Bred cows can get by on minimal forage if not suckling calves.
4. Skip keeping replacement heifers, or keep young, healthy open cows instead of heifers. It is costly to feed without a calf for income.
5. Use existing forage resources efficiently. Although carrying capacity is lower during drought, improved grazing management may minimize this loss. Examples include:
   - Delay turn-out to permanent pastures by feeding carryover hay or by grazing meadows, early alfalfa growth, or winter cereals. A one- to two-week delay in turn-out can increase forage production 10% or more when soil moisture is limited.
   - Erect temporary cross-fences within larger pastures to concentrate grazing in one small area at a time. This encourages cattle to more completely utilize whatever forage is available and defers grazing on the other pastures, allowing them to accumulate more growth before being grazed. Be sure to provide enough time for adequate plant recovery before grazing the pasture again.
   - Skim or flash graze each pasture very briefly with a high concentration of livestock early in the grazing season to use plants that otherwise would become mature and left ungrazed if grazing is delayed. Typical examples include sedges, cheatgrass and downy brome, bluegrass and early forbs.
   - Take advantage of weedy growth in crop residues and pasture patches as well as roadsides, woodlots, etc. as permitted. Temporary electric fencing, and sometimes hauled water may be needed to control when and where cattle graze these areas.
   - Be especially cautious of poisonous plants as well as nitrates, prussic acid and grass tetany. Many plants that are not toxic or are not normally consumed may poison livestock when forage supply is low.
   - Avoid overgrazing rangeland, otherwise recovery following drought will be slow and production depressed for an extended time.
   - Time grazing in pastures with questionable water supply or quality early in the grazing season when water demand by cattle will be less. Hauling water or pumping it through a pipeline may be needed for remote areas.

Finally, additional forage supplies can be developed. These options must be chosen with great care because they may be expensive relative to other alternatives, such as destocking. Among the alternatives are:

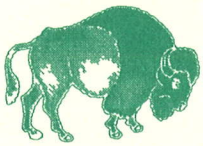
1. Cut winter wheat for hay instead of grain, especially if low grain yields are expected.
2. Plant oats as early as possible for grazing or hay. Oats use spring moisture very efficiently to produce forage. Under irrigation, oats often can be harvested early enough to permit double cropping of corn silage or a summer annual forage grass.
3. Use alfalfa for pasture instead of hay. Of course, other winter feed supplies then may be needed. Protect cattle from bloat.
4. Green chop alfalfa or hay meadows daily instead of grazing or harvesting as hay. This minimizes losses and stretches feed supply to its maximum.
5. Plant summer annual forage grasses like sudangrass and millets. These plants are drought resistant but will need some summer moisture for economical growth.
6. Graze corn, especially dryland corn with depressed yields. Corn provides high carrying capacity and quality for a "salvage" operation, but introduce cattle to it slowly to avoid digestive problems.
7. Buy and store hay while it is inexpensive.

More information is available at local Extension offices, including Extension Circular EC91-123, *Drought Management on Range and Pastureland.*

Editor's Note: This article is reprinted with permission from the April 2000 issue of *Nebraska Cattlemen.*

Bison and Grasslands: Living in Harmony with Nature

by David Hutchinson, Perfect Ten Bison Ranch, Rose, Nebraska



Bison are natural grazers that enjoy roaming the land. They range and forage through the grasslands effectively within family units and without tearing down the native rangeland. Bison grazing helps restore native grasses and improve soil quality. The hoof action breaks up the dead material and the crust of the ground, which allows the water to percolate into the ground to feed the grass roots. This keeps the biological circle healthy. The bison's microbial action in the stomach makes the grass it eats very valuable, whether it grazes on the active growing grasses in the growing season or the dormant grasses in the winter. Grasses have been the food mainstay for the bison's diet for thousands of years. Let us keep this majestic, unique, authentic animal in its natural habitat.

Bison are uniquely adapted to consuming both short and tall grasses on the prairie. In the 1700s, the range of the bison was vast, extending across the continent. The bison's heartland was the Great Plains, from Canada to Texas. The grass in the prairie is very diverse. The greatest part of prairie is found below the surface in the roots capable of reaching twelve to fifteen feet deep. The species of grasses are able to exist because of roots at different depths, light requirements at different heights, and having demands on the soil at different times in the growing season. The family units of the bison function in much the same way. The bison will protect and communicate with each other to ensure the safety of the entire herd.

Bison are suited to harsh winters on the plains. Ranchers rarely lose any of their herd to the elements. Cattle are not native to North America, and it shows in their survival rates. Bison are more in harmony with nature. They have seven times more hair follicles than beef animals. Water cannot penetrate their thick woolly, winter coats. Bison will face a storm head on, which allows snow to drift behind them. Bison also blow steam out of their nostrils, which keeps their breathing passages from freezing and prevents suffocation. Bison use their beards to brush away snow from the grass underneath and require no additional feed in the winter. In winter the bison's metabolism slows down, allowing them to stay warmer, while the cattle's metabolism speeds up. During the memorable snowstorm of 1949, thousands of cattle perished due to cold and suffocation from the snow. Almost half a century later, the harsh winter of 1996-1997 took a toll on cattle. Blizzards in North and South Dakota caused an estimated 395,000 cattle to succumb. Only one bison was lost, and that is because it strayed onto a highway and was struck by a semitrailer.

When winter is over, bison begin to frolic. They roll in the soil, rub on trees and begin to shed their winter coats. This helps replenish their pastures. Bison, are the most efficient harvesters around. Seeds of natural grasses caught in the winter coat are redeposited in the soil as they roll on the ground to remove winter hair. Losing winter hair allows them to prepare for the heat of summer. The bison also kick up clods of dirt with their sharp hooves in the spring, breaking up the still frozen ground. Water can then percolate more easily, guaranteeing the grass roots will receive needed water from rains. In the fall, bison break down dead grass by rolling on the ground as well as breaking it with their hoofs. Once the grass is broken, it decomposes into the soil, and the seeds grow easily the next spring. Bison also use their hooves to work manure and urine back into the soil. On cattle ranches, beef hooves create problems. Their hooves are flat and round, which can establish ruts and kill grasses. Rain has trouble percolating through the packed soil. Cattle also tend to bunch up in one spot in the pasture and leave behind an area that is overrun. The ruts they create are almost impossible to reverse. Bison create the opposite effect; uneven land is leveled out as they break down rough areas. The bison aerate, nurture, and fertilize the ground, demonstrating an animal supremely adapted to its natural habitat.

Bison raised on grass, without grain, provide a very healthy meat product. The ratio of Omega-3 to Omega-6 fatty acids provides health benefits that may be linked to decreased heart disease, cancer, learning disabilities and a multitude of other diseases.[1]

Bison raised on natural grasses with varied species of scrubs, vegetation, etc., in the wild have all that is necessary to achieve their potential. If left alone, the bison will perform on its own strengths with ample water and pasture to support development into a supreme product that is one of the most delicious and tender pieces of meat one could ever be introduced to.

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[1]See *Why Grassfed is Best* by Jo Robinson, Vashon Island Press, 2000, pp. 13-15, 19-26; *The Omega Diet* by Artemis P. Simopoulos, M.D., and Jo Robinson, Harpers Perennial, 1999, pp. 6-31, 61-74, 77, 98.

Editor's Notes: The above article was excerpted with David Hutchinson's permission from a presentation he made in April at the University of Nebraska's Center for Great Plains Studies symposium, *Bison: the Past, Present, and Future of the Great Plains*. A Bison and Grass Tour will be held at Hutchinson's ranch on June 24, 2000. For details, contact the CGS office.

Plains Bison
Bison bison bison

Not long ago, people crossing the Great Plains could hear the rumble of bison herds moving across grasslands in search of good grazing areas. These herds were recorded by travelers and explorers as numbering in the millions. Today, although bison do not exist in the numbers they did a century ago, they are making a comeback in our culture.

Bison have existed on the North American continent since the Ice Age, when two species, a giant bison and a smaller bison, crossed the Bering land bridge that connected Siberia and Alaska about 100,000 years ago. The smaller bison survived the Ice Age and evolved into the modern bison (*Bison bison*), which later evolved into two subspecies known today as the plains bison (*Bison bison bison*) and the woodland bison (*Bison bison athabascae*).

Many people refer to bison as buffalo, although this is a misnomer. True buffalo are animals like the water buffalo found in Asia. The "buffalo" that used to range from Canada to Mexico and from New York to California are more correctly called bison. Although both buffalo and bison belong to the ox (bovid) family, they are scientifically different.

Plains bison have a herd instinct and thrive in large groups. As a herd animal, they are constantly on the move and have been characterized as nomadic. They quickly deplete grass in one spot, requiring the herd to move on to find ungrazed, preferred forage.

These herds helped shape the Great Plains into a complex, biologically rich system of grasslands. Their distinct grazing habits, which have evolved over centuries, promote the diversity of this natural community.

Bison are able to survive the harsh winters by plowing their heads into the snow to get to short prairie grasses that retain nutritional value during the winter better than other grasses. Adapted to temperatures ranging well below zero, they don't require additional food for energy during cold weather.

In spite of their bulk, bison are agile and fast, having been clocked at speeds of 40 miles per hour. This is faster than a horse can run, let alone a person trying to get close for that perfect photograph.

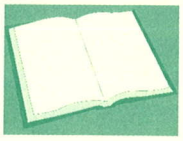
Today, non-native and Native Americans still use many parts of the animal. The meat is used for food, the hide for leather, garments are knit from the wool, and the skulls are used for decoration. The Nature Conservancy uses bison as part of the grassland management program at the Niobrara Valley Preserve. Along with fire and climate, bison help to maintain a dynamic prairie landscape.

To increase genetic diversity, the Conservancy recently started a new herd with the purchase of 120 heifers at the Niobrara Valley Preserve. "We are still actively raising money to pay for the new herd," says Vince Shay, Nebraska State Director. "We send out special Bison Stock Certificates to people who contribute $50 or more to this project. These certificates have proven to be especially popular as gifts to children, grandchildren, nieces and nephews." Donations can be sent to the Nebraska Field Office, 1722 St. Mary's Ave., #403, Omaha, NE 68102. Please specify that your gift is for the "Buy Stock in Bison" project.

A bison tour will be available during the Nebraska Chapter's annual meeting on June 10 at the Niobrara Valley Preserve. Visitors will be able to view bison grazing in their native habitat.

Editor's Note: This species profile is reprinted with permission from the Spring 2000 issue of *The Plains Messenger* published by the Nebraska Chapter of The Nature Conservancy.

Resources



Precious Heritage: The Status of Biodiversity in the United States. This book, written by scientists from The Nature Conservancy and the Association for Biodiversity Information, describes findings of a new study released March 16 that features the most complete analysis of U.S. plants and animals ever conducted. By documenting the presence in America of more than 200,000 native species—double the previous estimate, the study highlights the U.S. as a globally important center of diversity, home to fully 10% of all species described by science thus far. For more information on the findings of the study or how to order the book, see The Nature Conservancy's Web page, www.tnc.org.

"Bison: The Past, Present, and Future of the Great Plains" was the theme of UNL's Center for Great Plains Studies' 24th interdisciplinary symposium April 6-8 in Lincoln. More than 500 people gathered to hear presentations on such topics as the link between the fate of the bison and the impact caused by the environmental and human factors, prehistory and archaeology, indigenous perspectives, preservation, Canadian and European bison, grazing and production, management and nutrition, influence in Metis culture, and comparisons of bison in literary and artistic sources. Two Center publications will publish some of the presented papers in their spring 2001 issues: *Great Plains Research*, 402-472-6970; and *Great Plains Quarterly*, 402- 472-6058. Contact the numbers given for order information, or see www.unl.edu/plains.

Storing Carbon in Agricultural Soils to Help Mitigate Global Warming. $3. New report from the Council for Agricultural Science and Technology states: "The same farming practices that promote soil conservation can also decrease the amount of CO_2 accumulating in the atmosphere and threatening a global warming. Agricultural practices that conserve soil and increase productivity while

(continued on page 8)

Use of Prescribed Fire *(continued from page 1)*

Burning during the wrong environmental conditions can harm desirable plants. Plant growth may be reduced if soil moisture is low at the time of the fire. In most cases, fires should not be set unless winds are at least 5 mph from a consistent direction. This allows the fire to be controlled and directed. Light and variable winds will cause the fire's direction to shift erratically, making control difficult.

Improper fire timing can reduce plant productivity. If increasing warm-season tallgrass growth is the goal, grasses should be burned just before or during growth initiation, from mid-April to early May. Yields will be reduced if these grasses are burned when growing actively. If such a burn is too early, cool-season grasses will increase and deplete soil water and nutrients before warm-season grasses begin growth.

Special Uses of Prescribed Fire

Conservation Reserve Program Lands. Prescribed burns on Conservation Reserve Program (CRP) lands planted to warm-season grasses, especially switchgrass, can be unusually intense because of high fuel loadings. With proper planning, burning CRP sites actually is safer than burning many pasture or rangeland sites. Many CRP sites already are all or partially bounded by effective firebreaks, such as roads, tilled fields, or other non-flammable areas. As former cultivated fields, the edges of CRP sites are accessible to equipment, so firebreaks can be mowed or tilled before the burn date. Finally, the surplus of available fuel means that CRP sites can be burned under cool, damp conditions that will reduce fire intensity yet still allow management objectives to be achieved. More information on burning CRP sites is available in NebFacts NF 96-268, *Conducting a Prescribed Burn on Warm-Season Grass CRP Sites*.

Eastern Redcedar Management. Eastern redcedar trees are invading many Nebraska grasslands. These infestations reduce forage production and will only worsen with time. The periodic use of prescribed fire is essential in eastern redcedar management to inexpensively reduce initial tree numbers and to prevent reinfestation. If eastern redcedar management is the primary objective, some variations in the usual practices may be desirable. For example, an earlier burn date (around April 1) may provide better control than the May 1 date generally recommended for warm-season grass management because eastern redcedar foliage is drier and more flammable before spring growth begins. More information on integrating prescribed fire with other control measures is available in NebGuide G96-1308, *Management of Eastern Redcedar on Grasslands*.

Smooth Sumac Management. Dense stands of smooth sumac reduce forage production and accessibility. Fire alone is ineffective against smooth sumac. While the aerial stems may be top killed, the plant will resprout from root buds. In recent Nebraska research, 2,4-D ester at 2 lbs. active ingredient per acre applied to the foliage provided nearly complete control. However, fire can play a role in smooth sumac management. Reduction of canopy height may ease herbicide application. In addition, fire will help rejuvenate warm-season grasses that have declined in vigor and productivity under the canopy. More information on smooth sumac control is available in NebGuide G97-1319, *Management of Smooth Sumac on Grasslands*.

Fire and Wildlife Habitat Management. Burning can benefit many wildlife species by increasing habitat diversity as well as the nutritive quality, availability and yield of seeds, browse and forage. A common misconception is that many animals are killed by fire. Animals usually escape by running or flying away, going below ground, or moving to unburned islands of vegetation. The primary fire effect on wildlife is habitat alteration, not mortality. Many upland birds, including game birds, enter their peak nesting period in May. Thus, fires conducted in early April will avoid most nest destruction. Also, while entire pastures should be burned when grazing is the primary use, habitat sites can be divided so that only a half or third is burned in a given year. This will provide a refuge for animals excluded from the burned area, and increase habitat diversity because burned and unburned areas will develop different canopy structures, litter accumulations, and to some extent, plant species.

CGS Associate News

David Baltensperger and **Lowell Moser** were elected to the Nebraska Hall of Agricultural Achievement this year.

John Doran was recently honored by USDA with the Technology Transfer Award for developing a field kit that measures soil properties, such as water infiltration and organic matter content, as indicators of sustainability.

Don Adams received a Senior Faculty Teaching Excellence Award at a March banquet honoring all recipients of the Holling Family Award Program.

Turfgrass Drought Stress

by Robert (Bob) Shearman, Department of Horticulture, University of Nebraska-Lincoln

Turfgrasses were exposed to drought stress in many parts of the U.S. during the 1999 growing season. It appears that drought may be an issue in 2000 as well. While drought stress is most common in semiarid or arid regions, it often occurs in areas with high annual rainfall due to uneven seasonal distribution of precipitation. Irrigation is generally required to maintain actively growing turfs, especially when the site is intensively used.

Drought resistance is defined as the means that plants use to withstand periods of drought. Turfgrasses use three types of drought resistance to reduce drought stress and injury. Drought *avoidance* is the ability of a plant to avoid tissue damage in drought periods by postponing dehydration through reduced evaportranspiration (ET) rates, extracting more moisture from the soil profile, or a combination of these factors. Drought *tolerance* is the ability of the plant to tolerate drought through greater tissue and cell membrane tolerance to desiccation. Drought *escape* is the process where a plant has a life cycle such that it lives through periods of drought in a dormant state, like seeds. Hardiness also plays a role in drought resistance of turfgrasses. Drought hardiness is the process where turfgrass plants develop greater tolerance to tissue water deficits. Hardiness is influenced a great deal by environment and cultural practices.

Turfgrass species and cultivars differ in their drought resistance capabilities. Some turfgrass species use tolerance mechanisms to resist drought stress injury. Buffalograss, for example, is a drought tolerant species. When exposed to drought stress conditions, it rapidly ceases growth and becomes dormant, waiting until adequate moisture becomes available before initiating new growth. It tolerates tissue desiccation over extended periods of drought. Other turfgrasses, like tall fescue, are drought avoidant. When exposed to drought stress, tall fescue often continues to grow even though it has a relatively high water use rate. It does so because it has the ability to form a deep, extensive root system that draws moisture from deep within the soil profile. Bermudagrass is both drought tolerant and drought avoidant, making it a very adaptable species for use in moisture-deficit situations. Some annual species, like annual bluegrass, simply escape the drought stress by forming seed, maturing and dying. Once the stress is gone, the seed germinates and re-establishes the annual's life cycle.

Mowing, fertilization, irrigation, plant growth regulators and other cultural practices influence turfgrass drought resistance. These cultural practices, alone or in combination, can be manipulated to reduce ET rates, increase depth and extent of rooting, and enhance hardiness. Sometimes cultural practices will reduce ET but adversely impact both hardiness and the depth and extent of rooting. For example, close mowing and excessive nitrogen fertilization reduce turfgrass depth and extent of rooting (i.e., reduced drought avoidance), while increasing tissue hydration (i.e., decreased drought tolerance).

Drought stress conditions require turfgrass managers to use a systematic approach to reduce the potential for turfgrass stress and loss of stand. Selecting adapted species and cultivars is one of the first steps needed to reduce problems. This should be followed closely by the careful manipulation of cultural practices to minimize water use, increase depth and extent of rooting, and enhance plant hardiness. Grass selection and cultural practice manipulation will differ based on the intensity of turfgrass use and the frequency of drought stress occurrences.

Info Tufts

Drought plagues at least 10% of the nation annually, costing roughly $6-$8 billion. The nation's worst recent drought in 1988-89 cost $39-$40 billion. The internationally known National Drought Mitigation Center is a rich resource for drought information (http://enso.unl.edu/ndmc). The Center is located on the UNL campus and is headed by CGS Associate Don Wilhite.

In February the U.S. Fish and Wildlife Service announced that while an extensive review had determined the black-tailed prairie dog warrants listing under the Endangered Species Act, there are other species in greater need of protection. Therefore, "the Service is not proposing to list the species at this time."

A recent study found that the single biggest threat to species survival is loss of habitat, with almost 60% of America's landscape already severely altered (see *Precious Heritage* in Resources).

According to an article in the February 24 issue of the journal *Nature*, scientists who inventoried Earth's shrinking wilds have concluded that more than one-third of the planet's plant and animal species exists exclusively on 1.4% of its land surface.

A single spade full of rich garden soil contains more species of organisms than can be found above ground in the entire Amazon rain forest.

Resources *(continued from page 5)*

improving soil quality also increase the amount of carbon-rich organic matter in soils, thereby providing a global depository for CO2 drawn from the atmosphere by growing plants. CAST, 4420 West Lincoln Way, Ames, IA 50014-3447, 515-292-2125, cast@cast-science.org. Online version available at CAST Web site, www.cast-science.org.

Sustainable Turf Care is an online publication from the federally-sponsored Appropriate Technology Transfer for Rural Areas (ATTRA). It is written both for individuals with lawns and for professional golf course superintendents. Emphasis is placed on management practices that enhance soil fertility, thus decreasing the need for "rescue" efforts. Cultural practices (using correct fertilization, applying compost, irrigating properly, choosing the right grass variety, and mowing appropriately) are discussed, as well as least-toxic controls for insects, diseases, and weeds. See it at www.attra.org/attra-pub/turfcare.html.

Ecosystem Valuation is a Web site containing the following sections: The Big Picture (purposes and context for ecosystem valuation), Essentials of Ecosystem Valuation (non-technical explanation of the economic theory), Dollar-Based Ecosystem Valuation Methods, Ecosystem Benefit Indicators, case study illustrations of each method, and more. There is also a Feedback section that serves as a forum for users to share their experiences with ecosystem valuation. See www.ecosystemvaluation.org/.

Congratulations to CGS Associate **Duane Hovorka**, executive director of the Nebraska Wildlife Federation, who received the prestigious Charlie Shaw Award at the National Wildlife Federation's annual meeting in March. He was honored for his work with the Platte River Cooperative Agreement.

Calendar

Contact CGS for more information on these upcoming events:

2000

June 8-9:	Grazing Retreat, Ravenna, NE
June 17:	Applegait Ranch Tour, Sutherland, NE
June 22:	Turfgrass Seed Field Day, Scottsbluff, NE
June 24:	Bison and Grass Ranch Tour (featuring Allan Nation), Rose, NE
July 8:	The Grain Place tour, featuring Jo Robinson, author of *Why Grassfed Is Best*, Marquette, NE
July 16-19:	American Forage and Grassland Council and the North American Alfalfa Improvement Conference Annual Meeting, Madison, WI, www.forages.css.orst.edu/Organizations/Forage/AFGC/Conferences/#AFGC
July 16-20:	17th North American Prairie Conference, Mason City, IA, www.niacc.com/prairie2000/
July 18-20:	Grazing Retreat, Center, NE
July 25-26:	Grazing Retreat, Franklin, NE
Aug. 29-31:	Carbon: Exploring the Benefits to Farmers and Society, Des Moines, IA, www.cvrcd.org/carbon.htm
Aug. 7:	Turfgrass Field Day, Mead, NE
Aug. 29-30:	Alternative Ag Expo, Sioux City, IA
Sep. 13/14/15:	Grazing Tour with Burt Smith, Crofton/Atkinson/Imperial, NE
Sep. 16:	Festival of Color, Mead, NE
Oct. 15-19:	Bioenergy 2000: Moving Technology into the Marketplace, Buffalo, NY
Dec. 5-8:	National Conference on Grazing Lands, Las Vegas, NV, www.glci.org/Call.htm

If you have articles, events, resources, CGS Associate News, or other items you would like to submit for inclusion in future issues of this newsletter, please contact the editor, Pam Murray, at the CGS office.

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