

Center for Grassland Studies

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Managing Intensively Used Turfs

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

Intensively used turfgrass sites are especially exposed to wear injury and compaction stress. The immediate effect of trafficking any turf is wear injury, which results from the crushing, tearing, and shearing actions of foot or vehicular traffic. The longer or more chronic effects occur from compaction injury. Compaction stress coincides with increased bulk density, loss of soil structure, reduced large pore space, poor aeration, reduced oxygen diffusion rates, decreased water infiltration and percolation rates, and increased soil temperature variation. These soil changes result in poor growing conditions and an overall decline in turfgrass growth, vigor, persistence, and quality.

Turfgrass wear injury is easily recognized. The crushed, injured plant tissue quickly desiccates and turns straw brown. However, compaction stress injury is often subtle and can be easily confused with other environmental stress injuries, like heat and drought.



Intensively used turfs, like golf course putting greens, are subject to wear injury and soil compaction stress.

Turfgrass Species and Cultivars

Turfgrass species and cultivars differ in wear and compaction stress tolerance (Table 1). Warm-season species, like bermudagrass and zoysiagrass, are generally considered to be more wear tolerant than most cool-season turfgrass species. Tall fescue is an exception; it has excellent wear tolerance.

Table 1. Turfgrass Species and Their Relative Traffic Stress Tolerance.

<i>Species</i>	<i>Wear Tolerance</i>	<i>Compaction Tolerance</i>
Bermudagrass	Very High	Very High To High
Zoysiagrass	Very High	High To Medium
Tall Fescue	Very High to High	Medium
Perennial Ryegrass	High	Very High to High
Kentucky Bluegrass	Medium	High to Medium
Creeping Bentgrass	Medium to Low	Medium to Low
Hard Fescue	Medium to Low	Medium to Low
Creeping Red Fescue	Low	Low
Chewings Fescue	Low	Low
Annual Bluegrass	Very Low	Very High to High
Rough Bluegrass	Very Low	Very Low

Bermudagrass has very good soil compaction stress tolerance, which combined with excellent wear tolerance makes it one of the best species to use for highly trafficked sites. This is true except when bermudagrass is dormant. Trafficking dormant turf results in a significant decline in turfgrass traffic stress tolerance because dormant turfs can not recover quickly from wear injury. Dormant warm-season turfgrasses are often overseeded with cool-season species, like perennial ryegrass, to improve their appearance, playing quality, and traffic tolerance.

(continued on page 6)



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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.

Note: Opinions expressed in this newsletter are those of the authors and do not necessarily represent the policy of the Center for Grassland Studies, the Institute of Agriculture and Natural Resources or the University of Nebraska.

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FROM THE DIRECTOR

Most demographers believe that we are headed for a world population of 8 to 8.5 billion people in the next 20 to 30 years—thus an increase of some 2 billion people. With the demand for more food from population growth and increased consumption from the total population, we will see a significant increase in food demand. How will this demand be met?

At the National Agricultural Biotechnology Council meeting, held this past June in Lincoln, Dennis Avery indicated that free trade among nations has spread the wealth among more people throughout the world, and Per Pinstrup-Andersen pointed out that it will be the developing countries who drive this future demand for food. When people have more wealth, they will buy more food up to a certain level, and people seek a higher quality diet as income grows, which usually means more meat as the source of protein.

At the same time as the demand for food increases, we must develop agricultural systems that are environmentally friendly and sustainable. This usually means a greater use of grazing lands and livestock. Under this scenario, new frontiers appear to be in the area of biological improvement in plants and animals. This is where genetic engineering and biotechnology have a role.

Improvements have been made in plants and animals through breeding and management systems over many years, but now tools are available where changes can be made much faster, and using much greater divergence among species. We should be able to develop improved plants for grazing in a considerably shorter time frame using these new tools—plants that are more productive, more palatable, more digestible, and provide better gain in grazing animals. Likewise, with these new tools we should be able to produce animals that make better utilization and gain from grazing, more nutritious meat, and healthier food products.

Genes that code for highly specific characteristics can be transferred rapidly among plants and animals of the same or different genera and species, thus creating new plants and animals carrying those specific genes plus potentially other new genes. This is where much of the discussion is occurring relative to genetically modified organisms (GMOs). Some people who are opposed to using GMOs indicate that we don't know what other genes we are carrying along when we transfer a specific gene, and especially from widely divergent plants. Some say that new plants created under these conditions are more likely to carry toxins, allergens or other undesirable characteristics, and therefore should not be used. Some believe that these unintended consequences are more likely to happen when the new techniques are used to cross plants from widely different backgrounds, rather than the more traditional breeding techniques that involve more closely related species. On the other side, many believe that these new tools and methods for improving plants and animals are the only and the best way to meet the world's increasing demand for food using approximately the same land area that is now under cultivation.

In summary, it appears we must use the best science and technology available to meet the world's future food needs while protecting the environment and making certain that our food supply is safe and secure. New plant and animal products must be adequately tested and evaluated before they reach the trade channels. These are some of the challenges facing our scientists working through the Center for Grassland Studies.

M. A. Massengale

Management Practices and Plant Diversity on Some Privately-Owned Meadows in the Middle Loup River Valley

by Steven Rothenberger, Department of Biology, University of Nebraska at Kearney

Native, undisturbed meadows are uncommon within the Republican, Platte, and Loup River Valleys in Nebraska. To maximize productivity, most acres have been converted to cropland, heavily grazed, interseeded with exotics and fertilized, or frequently mowed. Recent research in the Middle Loup River Valley by the University of Nebraska at Kearney and the Nebraska Game and Parks Commission has resulted in the discovery of a number of pristine meadows with a low degree of disturbance located in Sherman, Howard, Custer, and Platte Counties.

Procedures and Results

More than 60 sites along the Middle Loup River, including wet meadows, wet mesic prairies, marshes, island sandbars, and woodlands, were surveyed ecologically during the 1996 and 1997 growing seasons. The study area extended from near Dunning in Blaine County to Columbus in Platte County. Additional floristic analysis and reconnaissance were completed in 1998. As part of a separate study, birds, mammals, reptiles, and selected invertebrates were also tallied. A total of 565 vascular plants, representing approximately 30% of Nebraska's total flora, were found in the study area. Dominant graminoids included representative sedges (*Carex*, *Scirpus*, *Cyperus*, *Eleocharis*), rushes (*Juncus*), and grasses (big bluestem, Indian grass, red top). In fact, 16 species of the sedge genus *Carex* were found at one site alone, and at least 32 members of this genus were recorded over the duration of the study.

Twelve plants listed as rare by the Nebraska Natural Heritage Program were identified during the study. A target species, the endangered western prairie fringed orchid, was not observed. Several interesting discoveries in this region included the white lady's slipper orchid, northern green orchid, loesel's twayblade, western wood lily, and swamp lousewort. Four rare sedges (*Carex* spp.) were identified, highlighted by the first report of *Carex buxbaumii* in Nebraska since 1939. These sites also provide habitat for uncommon birds, mammals, reptiles, and amphibians. For example, the rare smooth green snake, *Opheodrys vernalis*, was observed at a Sherman County Meadow.

A striking feature in these meadows is the low number of exotics and noxious weeds. Although redtop is common, aggressive introductions such as tall fescue, reed canary grass, and smooth brome are uncommon on native sites. Reed canary grass is becoming a major problem in the lowlands and floodplain reaches of the Republican and Platte Rivers; it tends to form thick monocultures that crowd out native species. Evidently, native competitors and habitat differences still limit its spread along the Loup.

Problematic forbs and woody plants such as green leafy spurge, Canada and musk thistle, red cedar, and siberian elm are scarce or almost nonexistent on undisturbed sites. Purple loosestrife, a noxious weed, has yet to invade the Loup Valley as it has the Platte River and its associated manmade wetlands. Hopefully, the seed mixes used in meadows and roadside restorations can be carefully evaluated to minimize the spread of problem species.

Management

Of 23 wet meadow sites in our survey, more than 50% are grazed or disturbed by frequent mowing. The ungrazed, native wet meadows are generally mowed just once, later in the growing season (July or August). One land owner specifically withholds grazing and mows only in late August, which helps to maximize forb production. The dominance of highly productive, native graminoids on these sites and the low frequency of introduced cool-season grasses, Kentucky bluegrass and smooth brome, are remarkable. When compared to adjacent grazed meadows, differences in species composition are inevitable. Grazing and trampling provide the disturbance needed for invasion by weedy species. However, the integrity of wet meadow vegetation may be maintained in part by using a grazing rotation system or by carefully monitoring stocking rates.

The subirrigated nature of floodplain meadows does limit the available land-use options, but this has not prevented conservation-minded land owners from effectively managing these fragile lands. In reality, the plant diversity exhibited by the showy forbs mixed with native grasses is a source of pride and satisfaction to several land owners. The Biology Department at the University of Nebraska at Kearney will continue to conduct research along the Loup River, primarily in Sherman County. One of our major objectives is to work with local residents to help ensure that the high-quality meadows are preserved.

Conclusions

Despite the attention given to the critical habitat found in the Platte River's Big Bend Region and to the Niobrara and Republican Rivers, the Loup River Valley remains one of Nebraska's lesser known treasures. The Loup's productive wet meadows are showy remnants of an unsettled past and are storehouses of species diversity as well. Conservation efforts here are of great ecological importance, and the unselfish actions of a few individuals have reaped rewards that will extend far into the future. I am certain that additional biological discoveries of significance will be made in the Loup River Valley.

Grassland Ecology Is Theme of CGS Seminar Series

The Center for Grassland Studies 1999 Seminar Series will again be held in the East Campus Union on Mondays, 3:30-4:30. Presenters will speak on various aspects of grassland ecology. The seminars are open to the public, beginning with the August 30 session and continuing through mid-December (except September 6, October 18 and November 1). They will also be videotaped and available for checkout from the CGS office. When it is finalized, the list of speakers, topics, and dates will be online at <http://ianrwww.unl.edu/ianr/cgs/seminars.htm>.

Students wishing to take the seminar course for undergraduate or graduate credit should contact the instructor, Dr. Martin Massengale, 402-472-4101, mmsengale1@unl.edu.

Grazing Lands Technical Assistance Available

The Natural Resource Conservation Service (NRCS) and the Nebraska Cattlemen (NC) recently joined forces to provide technical assistance on grazing lands in eastern Nebraska. This unique position has received tremendous support from agencies and producers in the area. While this partnership may seem unlikely at first glance, it really is a win-win situation. NRCS does not have the resources to have a Range Management Specialist in every office that works occasionally on range management. The union with NC was a natural one, since it is primarily cattle that utilize the range resources in this state.

Brenda Younkin, a Nebraska native, has been in the position for about eight months, and says that a day in the life of a Grazing Lands Specialist is a busy one. She was raised on ranches in the Sandhills, and has degrees in range management from UNL and Utah State University.

What, exactly, does she do? Younkin said that, in general, her days are spent doing site visits that are usually arranged through a local NRCS office. She said the various cost-share programs offered by NRCS have prompted producers to take greater interest in developing their range and pasture ground. She notes that these practices (cross-fencing, water developments, etc.) are expensive, and often the producer would like assistance deciding where to place fence and water developments, as well as advice on initial stocking rates and a continued grazing plan. That is where Younkin comes in. To date close to 30,000 acres have been inventoried and have grazing plans in place.

Younkin can be reached at Nebraska Cattlemen, 1335 H Street, Lincoln, NE 68508, 402-475-2333, byounkin@necattlemen.org.

Rancher's Forum October 6

The Nebraska Grazing Lands Coalition is sponsoring a rancher's forum in Maxwell, Nebraska on October 6, 1999. In the morning participants will hear from Nebraska Department of Agriculture Director Merlyn Carlson on the outlook of Nebraska's livestock producers from a state perspective, rancher Jack Maddux on the sustainability of Nebraska's ranching industry, Chad Vorthmann with the Nebraska Cattlemen Association on the Nebraska Beef Quality Assurance Program, rancher Dave Hamilton on the Certified Nebraska Corn Fed Beef Program, and regional ranch manager Burke Teichert on ecologically and economically sustainable resource management. The afternoon includes some tour stops, during which time rancher Wes Steel will give a historical perspective of area wildfires, UNL specialists Jerry Volesky and Don Adams will talk about effects of range fires and grazing meadowlands, and ranch manager Steve Boeshart will discuss recovery management for the rangeland burned by the recent wildfire in western Nebraska. After a Q&A session, the group will enjoy a beef cookout and tales by cowboy poet/humorist R.P. Smith.

To preregister, contact the Lincoln County Extension Service, 308-532-2683. For more information, contact Jeff Nichols at the NRCS office in Ogallala, 308-284-2048, ext. 3.



Looking for a Few Good Forage Publications

Jimmy Henning at the University of Kentucky is working on a project sponsored by the National Cattlemen's Beef Association and Dow AgroScience. The end product will include an organized database of forage publications. The database will have a broad scope and will include both pasture and range publications. If you know of a good source for forage related publications from universities, colleges or other similar sources that are available electronically (via the Web, or as a word processing file—internet access not necessary), please send the name of the publication and how it can be accessed to:

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Regional Grazing Project Approved

A major effort of the Center for Grassland Studies during the past two years has been coordination of the formation and continuing activities of the MINK (Missouri, Iowa, Nebraska and Kansas) Forage/Livestock Group, which involves researchers and educators from the land-grant universities and USDA ARS in the four states. One of those activities was submission of a regional research and education project titled, "Improved Grazing Systems for Beef Cattle Production." The project was recently approved by USDA CSREES, with funding to become available October 1, 1999. Below is a brief summary of the project as approved (objectives were later refined at the June 1999 MINK meeting). For details, contact the CGS office.

The states of Missouri, Iowa, Nebraska and Kansas contain over 19% of the nation's beef cow herd. In addition, these states annually finish about 12 million head of cattle, or nearly 43% of the nation's total. The four states also contain 57.2 million acres of pasture and range (includes crop land grazed), which is about 38% of their combined farmland acres. The four states also produce over 23 million tons of hay. Corn and sorghum cover 28.9 million acres, which is a huge grain supply and critical resource for aftermath grazing.

A large proportion of costs in the beef cow system comes from harvested and purchased feeds. In the MINK states, most of these costs are incurred when harvested forages and/or protein supplements are fed to cattle during periods when dormant forage is either in short supply or of poor quality. Because these costs often account for one-third or more of the total, it seems logical that a major reduction in harvested and purchased feed could enhance profitability of the cow-calf system. The elemental component of the project is that of "extended grazing," i.e., supplying more of an animal's annual nutrient requirements through grazing. This project will identify and test alternative systems of beef cattle production that can better utilize standing forages not only during spring and summer, but during fall and winter as well. The long-term goal is to produce nutritious and palatable beef with systems that optimize profitability and maintain environmental quality by improving the amount and efficiency of grazing. The hypothesis is that increasing the proportion of feed harvested by the animals will lead to improved sustainability and profitability of the beef industry.

The overall objective of the project is to develop and evaluate concepts and systems that increase the uniformity of the year-round forage supply and the efficacy of forage, animal and grazing management to improve the profitability of beef production. Specific objectives are:

1. To quantify production and economic impacts, including risk, of beef cow-calf systems that better match animal nutrient requirements to the quantity and nutritional value of the forage supply.
2. To improve the profitability and productivity of cow-calf systems by identifying alternative forage species and grazing management to extend the length of the grazing season.

3. Develop strategies for using forage legumes to improve the agronomic, animal performance, environmental, and economic characteristics of forage-beef systems.

4. Develop a systems-based educational program on integrated forage/cattle management systems for cow-calf producers in the four-state region.

Cost savings for beef cattle producers adopting systems that improve and extend grazing is one expected outcome. The researchers believe that beef cattle producers can save a minimum of \$50/calf from matching the cow's nutrient requirements to the nutrient density in grazed forages. If only 10% of the producers in the four-state region adopt these practices, annual costs would be reduced by about \$30 million. Cost savings and improved profitability are also expected from adopting systems emphasizing the use of crop residues and stockpiled forages to extend grazing. Even if one-half ton of hay per cow is saved from some of these practices, the net savings to a producer could be substantial.

An improved ability to design effective beef cattle systems for a wide range of climatic zones will also be an important outcome. Through an improved understanding of forage intake and the role iNDF plays, forage systems of more appropriate quality can be designed. Furthermore, the data will be used to develop the nutrient balance component of a grazing system decision support model that could be made available to the public as software. Knowing the impacts of winter grazing on plant vigor and yield of range grasses during the summer grazing period will contribute necessary information to assist researchers, educators and producers in designing sustainable winter grazing systems in the range areas of the region.

Systems that incorporate winter annuals may improve soil conservation as well as profitability for the beef enterprise. The winter annuals will provide high-quality forage to grazing beef cattle and protect vulnerable soils from water and wind erosion. Manure will be redistributed to the cropped area, thus improving soil fertility.

Tall fescue is highly productive in large parts of the study area. A better understanding of how this resource can effectively be utilized by beef cattle will enhance local economies and improve opportunities for more winter grazing. Improvement in forage quality from adding

(continued on page 7)

Managing Intensively Used Turfs (continued from page 1)

Perennial ryegrass offers the best combination of wear and compaction stress tolerance in the cool-season portions of the U.S. Tall fescue, on the other hand, has excellent wear tolerance but only moderate soil compaction tolerance. Tall fescue stands thin dramatically under intense traffic. Effective stands can only be maintained with regular interseeding and aerification.

Interestingly, annual bluegrass has very poor wear tolerance when compared to other turfgrasses, but is a very competitive species under compacted soil conditions. This is one of the reasons it becomes such a weed problem in closely mowed, intensively trafficked turfgrass conditions.

When turfgrass managers are uncertain about the traffic stress tolerance of turfgrass species or cultivars, it is best to check with researchers in their area for advice on which grasses to use. Data from the National Turfgrass Evaluation Program (NTEP) can be helpful as well. Select grasses that demonstrate vigorous, well-adapted growth and high quality performance in your region. Ancillary NTEP data on traffic tolerance may also be available. Research on turfgrass traffic stress tolerance has indicated that tolerance increases: a) as plant tissue succulence is reduced; b) with total cell wall content of plant tissue; c) with cellulose, hemicellulose, and lignin content; d) with increased shoot density, verdure, and load bearing capacity; and e) as rooting depth and extent increases.

Cultural Practices

Traffic stress tolerance increases with mowing height. Higher mowing heights produce greater verdure, root production, rooting depth and extent, and rhizome and stolon development than low mowing heights. Greater verdure has a cushioning effect on the crowns of heavily trafficked turfs. Cushioning the crown reduces the extent of wear injury and insulates the soil to a certain degree from soil compaction.

The overall approach to improve turfgrass traffic stress tolerance must include a well-balanced nutrition program that adequately meets the nutritional needs of the turfgrass plant. Soil tests should be used as the basis for the fertilization program. Turfgrass wear tolerance increases with nitrogen nutrition up to a critical point. Beyond this point, excess nitrogen results in lush succulent tissue growth that is more susceptible to wear injury. It is best to meet the nutritional needs of the turfgrass because both excess and deficient nutrition result in reduced traffic stress tolerance. Turfgrass traffic stress tolerance increases with potassium nutrition. In order to obtain wear tolerance benefits from potassium, applications prior to and during periods of intensive traffic give the best results. On sandy growing media, apply potassium in light frequent applications or use slow-release sources for improved performance.

Soil Cultivation

Soil cultivation should be an integral part of a management program for traffic stress tolerance (Table 2). Soil cultivation reduces runoff and increases plant water

uptake. The cultivation procedures like coring, slicing, spiking, and high pressure injection can be used to reduce soil compaction stress. Each procedure has its advantages and disadvantages. Core cultivation of intensively used turfgrass sites is one of the more beneficial procedures that can be used in reducing soil compaction, improving aeration, and increasing soil oxygen content. Intensively used areas should be cultivated at least twice a year. Cool-season turfgrasses are best cultivated when they are actively growing, i.e., spring and/or fall. Warm-season species should be cultivated after green-up and before they go dormant in the fall. Heavily used areas may require more frequent cultivation. Use small tines for cultivation during the playing season. Sometimes slicing and spiking can be used with minimal effects on play. Properly selected and used, coring, slicing, spiking, and high pressure injection can be effective for alleviating compaction stress and enhancing surface soil moisture conditions without disrupting play.

Table 2. Soil Cultivation Equipment and the Advantages of Cultivation on Heavily Trafficked Turfs.

SOIL CULTIVATION	SOIL CULTIVATION
Types:	Advantages:
Coring	Better Water/Fertilizer Uptake
Slicing	Reduced Runoff
Spiking	Better Rooting
High Pressure/Injection	Less Compaction
	Reduced Thatch

Traffic Control

Traffic control is an important component of managing intensively used turfs. Proper facility design is important in routing traffic and reducing traffic stress. By spreading the intensity of traffic over a large area, traffic injury is reduced, and recuperative potential is enhanced. Golf course superintendents use traffic control to their benefit by cup placement and movement, and by manipulating cart traffic as they leave the cartpath. Using barriers, like ropes and posts, helps to temporarily route traffic around potential problem areas. Cart and pedestrian traffic can also be distributed by using signage to direct traffic. Sports field managers reduce traffic stress by limiting practices, reducing miscellaneous foot traffic, and manipulating field boundaries. Developing adequate practice facilities also helps avoid stressing the primary turfgrass facility.

Conclusion

Selecting the proper turfgrass species and cultivars, manipulating cultural practices, and practicing traffic control procedures are parts of an overall approach to maintaining turfs on heavily trafficked sites. Regardless of the methods used, turfgrass managers must use their expertise to develop effective systems for maintaining quality turf on intensively used sites.

Editor's Note: For further information about NTEP, contact: Kevin Morris, Executive Director, National Turfgrass Evaluation Program, BARC-West, Bldg. 002, Rm 013, Beltsville, MD 20705, phone: 301-504-5125, fax: 301-504-5167, e-mail: kmorris@asrr.arsusda.gov.

Regional Grazing Project Approved *(continued from page 6)*

rhizomatous birdsfoot trefoil (RBFT) to fescue pastures will be another useful outcome of the proposed research. Data generated from the RBFT research plots and grazing trials should indicate a number of adaptability and utility criteria for RBFT compared to other legumes. The criteria for these locations would particularly relate to the claypan soils of southeast Kansas, southwest Missouri, northeast Oklahoma, and other soils that have poor internal drainage, shallow topsoil, and acid, low-phosphorus clay subsoils in a climate characteristic of the central plains. Specifically, relative ease of establishment and compatibility of RBFT with the highly competitive endophyte-infected tall fescue should be indicated from the results. Later, the persistence and ability to "spread" under those conditions should become apparent. Finally, the relative potential of RBFT to produce forage of the amount and quality needed in pastures of the region should be determined.

Dissemination of project results to both producers and peers is an important part of the effort. This will be accomplished by various means including field days, publications in university extension sources and popular press, radio, television, distance education media, newsletters, peer reviewed research reports and journal articles, and presentations at professional meetings. Participating scientists will also conduct training for county and area extension staff.

Moderate Grazing Promotes Plant Diversity

Scientists researching the interdependence of plants and animals have found that a moderate level of cattle grazing makes for a more diverse ecosystem—at least on the Great Plains.

"It evens out the production of individual plant species, preventing any one from dominating," says Richard H. Hart. He is a rangeland scientist with USDA's Agricultural Research Service. His conclusions come from a grazing study at the Central Plains Experimental Range (CPER) near Nunn, Colorado.

The range is managed by the ARS Rangeland Resources Research Unit, which is headquartered at the High Plains Grassland Research Station near Cheyenne, Wyoming.

The High Plains station recently celebrated its 70th anniversary. The CPER was established in 1937 on plowed or overgrazed lands abandoned by farmers and ranchers during the Dust Bowl years. So it's no surprise that the cattle-grazing experiment may well be the longest running rangeland grazing experiment in the world. Yearling heifers have grazed the range here for 5 to 6 months each year since 1939, continuing the work of previous cattle—and the buffalo before them.

In a study comparing rangeland grazed by low to high numbers of cattle, researchers have found that plant

biodiversity—as well as ranch profitability—is highest on land grazed moderately. "Moderate" is defined as one yearling heifer for every 16 acres for 5 to 6 months each year.

Plant biodiversity is highest when high numbers of plant species are combined with a more even distribution of production among species. Hart and his colleagues found 46 species of plants on the moderately grazed land, compared to 43 under heavy grazing and 36 under light grazing.

While totally ungrazed land had the same number of plant species as the moderately grazed land, its biodiversity was undercut by the dominance of prickly-pear cactus. Prickly pear contributed nearly half of the total standing crop vegetation. Moderately grazed land retained the same number of species, while reducing the prevalence of prickly pear to about 20%. It also reduced the dominance of blue grama and buffalograss, native prairie grasses that are encouraged by heavy grazing.

All in all, moderate grazing offers the best compromise when balancing numbers of species and their dominance with beef and forage production.

Hart says cattle weight gains decrease significantly when the land is grazed heavily, because there are not only more mouths to feed, but less forage to graze. The greater number of cattle does give the rancher more beef per acre, but the higher costs of maintaining more cattle cancels out this advantage.

This research is part of Grazinglands Management, an ARS National Program described on the Web at <http://www.nps.ars.usda.gov/programs/nrsas.htm>.

Source: Reprinted from *Agricultural Research* magazine, May 1999, published by USDA-ARS.

Info Tufts



On June 17 the Interior Department announced that the bald eagle is being removed from the Endangered Species list. The eagle was near extinction in the 1960s and began its recovery after the banning of the pesticide DDT in 1972. There are believed to be more than 4,500 pairs of bald eagles in existence today, compared to fewer than 450 in the late 1960s.



GREEN (GrassRoots Environmental Effectiveness Network) has started a new project called the State Biodiversity Network, and is looking for conservationists who are interested in setting up a network of citizens that are working on state or local level wildlife and wildlands protection. For more information, see <http://www.defenders.org/grnhome.html>, or contact the CGS office.

CGS Associate News

James Merchant was honored for exemplary service to the Nebraska geographic information systems community. He was presented with the first "outstanding contributions" award by the Nebraska GIS/LIS Association.

Resources



1998 Turfgrass Research Report. Free (limited quantity available). Annual publication contains brief reports on research conducted by members of the interdisciplinary Turfgrass Science Team at UNL. See <http://hort.unl.edu/turf/index.html> for the Team's home page and access to the online report. Contact the CGS office for a copy of the printed report.

1999 Nebraska Beef Cattle Report. Free (limited quantity available). Contains 31 research articles on a variety of topics related to beef production, including some on grazing. Summaries of all the reports may be obtained from Nebraska Extension educators. The report is online at <http://www.ianr.unl.edu/pubs/beef/report/mp71.htm>. For a printed copy of the report, contact the CGS office.

Grazing in the Northeast: Assessing Current Technologies, Research Directions, and Education Needs, \$30 + \$5 s&h, and *Priority Pasture Research and Education Needs*, \$5 + \$3.50 s&h, are available from Natural Resource, Agriculture, and Engineering Service, 152 Riley-Robb Hall, Ithaca, NY 14853, 607-255-7654, nraes@cornell.edu.

"Who's Coming to Dinner? Livestock Eating Habits and Their Effects on Grazing Management," a 15-minute video, is \$19.95 from Publication Orders, Extension & Station Communications, Oregon State University, 422 Kerr Administration, Corvallis, OR 97331, 541-737-0803.

Calendar

Contact CGS for more information on these upcoming events:

1999

- Aug. 28:** Festival of Color, displays of colorful water conserving flowers, children's activities and landscaping demonstrations, Mead, NE
- Oct. 6:** 1999 Rancher's Forum, Maxwell, NE
- Oct. 31–
Nov. 4:** ASA, CSSA, SSSA annual meetings, Salt Lake City, UT
- Nov. 8–9:** The Practice of Restoring Native Ecosystems National Conference, Nebraska City, NE

See also <http://www.forages.css.orst.edu/Contents/Conferences/index.html>

In 1998, the National Golf Foundation released a detailed study of "The Strategic Plan for the Growth of Golf." There were skeptics who questioned the results that predicted one new course a day for the next 10 years. With the 1988–1998 results in, and now realizing how correct they were, the National Golf Foundation's 1998 report, "A Strategic Perspective on the Future of Golf," will be given the credibility it deserves as we head into the next ten years.



Brad Schmidt, Landscapes Unlimited, Inc.

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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