Winter 1999

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From the Director

With the recent rapid changes and wide variations in weather patterns, especially temperature, I was prompted to think about outdoor perennial plants, and particularly, grasses that are place bound. Just how do these plants that are composed, at least in part, of living tissue cope with such wide ranges in temperature and wind chill factors over a short period of time, e.g., several degrees in one day.

Grasses that are able to survive the cold winters of northern climates have ways of adapting to these low temperatures. Perennial grasses adapted to northern latitudes undergo biochemical, biophysical and morphological changes during the fall of the year that increase their tolerance to low temperatures. These changes are triggered by falling temperatures and day length. We refer to these processes as "hardening off."

The degree of hardiness developed by the plant depends on a number of factors such as nutrition, water content of the cells, when hardening begins, the rate of hardening, and the consistency of that hardiness throughout the winter. If a plant loses hardiness too early in the spring, it can be damaged by a late cold spell.

Also, the amount of snow cover or other forms of insulation available will influence the amount of damage. Snow is a very good insulator, and the temperature of plants beneath snow cover can be several degrees warmer than the air temperature above the snow. On the other hand, ice conducts temperature better than either snow or air, and plants may be especially susceptible to cold temperatures when covered with a sheet of ice. Ice sheets also contribute to an anaerobic environment and the buildup of toxic metabolites, which can cause damage to plants.

Management techniques such as harvesting schedules, fertilizer application and improved drainage will all reduce the chances of low-temperature injury. Plants that are weakened by diseases, insects, early freezes or other kinds of damage are not as cold tolerant as healthy plants. This seems to be related to the ability of the plant to accumulate and transport compounds like carbohydrates, amino acids and water.

Fall dormancy is considered to be associated with winter hardiness. Plants that produce little or no top growth in the fall because of their dormancy are generally more winter hardy than those that produce more top growth. Perennial plants that grow in southern climates or the tropics are normally cold sensitive and appear to lack the photoperiodic sensing mechanisms to induce the required internal physiological changes for winter survival.

When you observe perennial plants such as the grasses in your lawn during the winter, remember the changes they have gone through in preparing for the harsh weather.

Factors Affecting the Biodiversity of Lowland Grasslands Along the Platte River

by Julie Savidge and Tammy VerCauteren, School of Natural Resource Sciences, UNL

Lowland grasslands occur within the flood plain of the Platte River in Nebraska. A moisture gradient occurs

among and within these grasslands, with some areas very wet (often referred to as wet meadows) and others more dry. In the wetter areas, you find characteristic wetland vegetation such as sedges and rushes. The dryer portions have more typical prairie vegetation such as big bluestem, switchgrass, and coneflowers. Historically, the Platte River periodically overflowed its banks and flooded these grasslands. The landscape was most likely a mixture of grazed and ungrazed grasses. Today, the majority of private land is either hayed or grazed (rotation or continuous) and most vegetation is short. Flows in the river have been greatly reduced. Over the past century, lowland grasslands, and wet meadows in particular, have declined largely due to conversion to agriculture and construction of gravel pits, roads, and homes.

These early studies found that abundances of breeding grassland birds were highest on the wettest fields, which were in a rotation system and were grazed after the bird surveys. Bird abundances were lowest on fields grazed either before or during the surveys. The greatest numbers of species were found on study areas with the tallest vegetation. Although certain bird species were most common on grasslands with tall vegetation, others were more abundant in fields with shorter stature. The highest abundances of small mammals occurred on the wettest fields, while grazed fields had the lowest relative abundances.

Invertebrates are a critical component of the food chain and snails are an important part of the diet of sandhill cranes, which stage along the Platte during their annual migrations. Some species of snails occurred only in moist fields and others just in dry, but snail densities were positively correlated with moisture. Ground-dwelling beetles showed distinct differences in abundance and composition between fields, and even between sloughs and drier ground within a field. Moisture, amount of decaying litter, and vegetation structure were important in determining beetle abundances and distribution.

Recent research has focused on factors affecting sandhill crane use of lowland grasslands. About 80% of the world's sandhill crane population stop over annually along the Platte River. Cranes begin migrating to Nebraska in mid-February and by mid-April have headed further north to their breeding grounds. The river serves as a primary roost site for cranes, and the adjacent lands provide essential nutrients and food to build up fat reserves. Cranes allocate about half of their time to agricultural lands where they consume waste grain. The rest of their time is spent in grassland habitats, which are important for social interactions and food. The invertebrates consumed in lowland grasslands provide essential nutrients to help balance the cranes' diet and prepare their bodies for reproductive activities.

Major habitat changes that affect cranes have transpired within the Platte River Valley over the past century. River flows have declined due to agricultural conversions and municipal uses. Changes in river hydrology have altered the morphology of the river by narrowing its width and encouraging the establishment of woody vegetation. Changes in the Platte River also impact adjacent lowland grasslands because of a hydrologic link.

In 1996-97, we studied crane use of 44 to 49 grassland fields along the Platte. Cranes did not use study sites where visual obstruction measures (a combination of vegetation height and density) were greater than 30 cm. One hypothesis to explain crane avoidance of fields with taller vegetation is that tall, dense vegetation may serve as cover for predators and make it difficult for cranes to forage for invertebrates. Fields with water table depths of more than 100 cm had limited crane use. Shallow water tables may force invertebrates closer to the surface, making them more available to cranes. Greater numbers of cranes also occurred on grasslands with more standing water. Water plays an important role in general maintenance activities and crane social interactions including pair bonding.

The sites most heavily used by cranes were pastures. Grazing helps keep vegetation stature down, and invertebrates associated with cow patties provide food for cranes. Many pastures had sloughs containing open water, and pastures that lacked standing water typically had stock ponds that cranes also used.

Thus, some species seem to benefit from grazing and others do not. These studies underscore the importance of moisture in lowland grasslands along the Platte. The wettest areas had the highest densities of birds, small

mammals, snails, and beetles. Both a shallow water table and surface water were important for cranes. We found a negative relationship between depth to ground water and amount of surface water in our study areas. Thus, if flows in the river continue to decline, the depth to the water table in adjacent fields can be expected to increase and the amount of standing water on fields to decrease. This would be an undesirable consequence for cranes and various other animals requiring standing water and or moist soils in these grasslands.

Lowland grasslands are complex and display a large amount of variability, in part due to differences in soil moisture. All phases are important but the wettest areas, which at one time were probably relatively common, are currently rare and need to be preserved to maintain native biodiversity along the Platte River.

Editor's Note: Tammy VerCauteren is a recent graduate student working with CGS Associate Julie Savidge.

Use of Exotic Plants in Sandhills Wet Meadows: An Ecological Viewpoint

by Gerry Steinauer, Botanist, Nebraska Game and Parks Commission

For decades, exotic grasses and legumes have been interseeded into Sandhills wet meadows and other native grasslands throughout the state. In the short term, these exotics might increase forage quantity and quality. However, they also displace native plants, degrade wildlife habitat, and, in the long term, may provide little economic benefit to ranchers.

Wet meadows occupy over one million acres of valley bottoms and flats in the Sandhills and, along with Sandhills marshes and lakes, form one of the largest intact wetland complexes in the Great Plains. Characterized by high water tables (usually within a meter of the ground surface), native meadows are dominated by grasses such as bluejoint, prairie cordgrass, big bluestem and switchgrass, as well as sedges, rushes and forbs. They also provide habitat for the federally-threatened western prairie fringed orchid, migratory and nesting birds, and other wildlife.

Since about the 1930s, Sandhills ranchers have interseeded their meadows with exotic grasses including redtop, timothy, smooth brome and reed canary grass, and with legumes including red, white, and alsike clover and alfalfa. These exotic plants were not part of the pre- settlement Nebraska flora; most are native to Europe or Asia. Though many ecologists and conservationists believe the interseeding of exotics into the meadows and other native grasslands is misguided, other professionals still promote the practice.

"We tend to think because it has forage value it is not bad, but when you introduce exotics, you're not really solving any problems," said Gene Mack, Sandhills Coordinator for the U.S. Fish and Wildlife Service (USFWS). "If every rancher planted every meadow to bird's foot trefoil [an exotic legume] and increased production, we'd end up with more livestock out there. But [the rancher's] profit margin will get even smaller. Then they'll have to find another species that will increase production and profit margins again. And the race goes on and on. The problem is not in the plants on the land, it's the economics. In the long term, what's going to happen is they [exotics] are going to destroy native habitats and cause more endangered species and you're still going to have people out there who can't make a living."

In Mack's opinion, the introduction of exotics and annual mid-summer haying has reduced the natural diversity and productivity of the meadows. Traditionally, most meadows are hayed annually between late June and August. The practice promotes the earlier maturing, cool-season exotics and facilitates their dominance over many later-maturing native plants, including productive warm-season grasses and legumes.

On the Valentine National Wildlife Refuge, the USFWS was able to stimulate native warm-season grasses and increase the productivity and protein content of their meadow vegetation through use of a rotational system of haying, grazing and periods of rest, Mack said. Dr. G. David Tilman, noted ecologist at the University of Minnesota, has found through long-term experiments that species-rich grasslands, such as native meadows, are more drought resistant than species-poor grasslands, such as exotic-dominated meadows.

Reed canary grass is one of the more aggressive exotics commonly seeded into Sandhills wet meadows and other areas of the state. Once established, the plant forms dense monoculture stands similar to cattails in marshes, which crowd out native plants. Reed canary grass rapidly spreads by water-borne seeds from seeded areas, and is now a problem species in flood plains and wetlands throughout the state. The plant is a poor food source for wildlife, destroys habitat structure, and provides poor nesting cover. If not hayed or grazed before maturity, the plant has little forage value. Expensive chemical and mechanical methods can be used to control reed canary grass, but new plants quickly reestablish from seeds in the soil.

Bird's foot trefoil is an exotic plant not yet well established in Nebraska, but it is being researched and promoted for use in Sandhills wet meadows. The plant is causing extensive damage to native grasslands in other areas of the country. "Here it was commonly included in seed mixtures for road right-of-ways and Conservation Reserve Program (CRP) lands," said Brian Winter, a land steward with The Nature Conservancy in Minnesota. "It's practically as bad as leafy spurge because of its ability to spread, create new patches and invade native plant communities. Mowing does nothing to control it. No biocontrol work is being done because it is still being promoted and propagated, so that is not an option. We pretty much wind up using chemicals and spend several weeks controlling infestations. Certainly, the best solution is not to be planting this in proximity to any sensitive areas because, from our experience, it is going to spread," he said. Because of their aggressive nature, bird's foot trefoil, reed canary grass, and crown vetch (one of several aggressive exotics also planted along Nebraska roadsides) are no longer recommended for CRP and roadside plantings in Minnesota.

Exotics plants now comprise nearly 25 percent (472 of 1,921 species) of the Nebraska flora. Most are poor competitors and might never invade native plant communities. But others are superior competitors, out-competing native species for sunlight, water and nutrients, and spread explosively into native plants communities, displacing native species and degrading wildlife habitat.

Through lack of foresight (and, more importantly hindsight) as to the ecological and economic consequences, exotic plants continue to be introduced for forage, erosion control, roadside seedings, landscaping and wildlife plantings throughout Nebraska. It is ironic that while certain taxpayers' dollars are being spent to conserve and protect wetlands and other native plants communities, other taxpayers' dollars are being used to promote and use exotic plants with the ability to severely degrade the same ecologically sensitive communities.

New Editor of Great Plains Research Solicits Manuscripts

by Svata Louda, School of Biological Sciences, UNL

The "changing of the guard" at Great Plains Research brings a different perspective to the journal. With this change has come a shift in editorial emphasis that I hope will make GPR a new outlet for synthetic, multidisciplinary scientific research relevant to the plains. As the new Editor, my aim will be to increase the availability of important ecological, economic and social sciences research results with relevance to the understanding and management of the Great Plains. This vast, ecologically rich and varied grassland region covers the whole interior of the North American continent, north from Texas to central Saskatchewan and east from the Rocky Mountains to the deciduous forest ecosystem, at about 95 west longitude. Its topography

and high productivity have allowed rapid and heavy exploitation, often in ignorance of the natural and social costs associated or how to mitigate them. Finding the relevant theoretical and practical scientific information needed to understand this region and to manage it intelligently is difficult at present. The relevant literature is diffuse and voluminous. This journal, with its focus on the region, can provide a way to concentrate relevant information and get it into the hands of the scientific community, the community leaders, and our public policy representatives.

The new editorial policy will encourage those submissions in particular that make general findings in the sciences relevant to this vast region. Articles being solicited now include thoughtful reviews of critical scientific findings and issues relevant to the Great Plains, whether the research was done in the Great Plains or not. The key will be how well the findings are related to the region, and how well the science is communicated to other scientists outside the specific discipline, in the style of the Scientific American, for example. The most successful paper will be acknowledged with the annual Leslie Hewes Award for the best article in the volume.

Several types of articles are of particular interest to me. These include:

- synopses of the "state of the science" on topics with relevance to the Great Plains;
- overviews of critical environmental, economic and social issues for the plains;
- reviews of knowledge on important questions and their regional application;
- syntheses and cross-disciplinary analyses with relevance to the plains; and
- original research findings, such as have been published in GPR since 1991.

I invite scientists doing interesting work with important implications for this region to synthesize their significant research results and present them and their relevance to this audience. The overall goal is to develop GPR as a centralized outlet for science of regional importance, to communicate important scientific findings to as wide an educated audience as possible, and to help keep the scientists and interested citizens and leaders of this region up to date on scientific progress relevant to the Great Plains.

To discuss your ideas, you can email me at: SLouda@UNL.edu. Or, better yet, to submit a manuscript directly, or to support this effort by subscribing ($25/yr/individuals), please send your materials to me at:

Svata M. Louda, Editor-Great Plains Research Center for Great Plains Studies 1215 Oldfather Hall, University of Nebraska Lincoln, NE 68588-0317

Role of Grasses In an Integrated Approach for Remediating TNT-Contaminated Soil

by Neil Heckman, Department of Horticulture, UNL

Soil contaminated with 2,4,6-trinitrotoluene (TNT) is a serious public health and environmental hazard. TNT has been shown to be toxic to many organisms, including humans. Many areas that are contaminated are former munitions operations sites, such as the former Nebraska Ordinance Plant near Mead, NE. Currently, the most common method of remediating the TNT-contaminated soil is incineration. This process is extremely costly, and it destroys the soil. Cost-effective and more environmentally benign treatments, including chemical oxidation and reduction, soil washing, and bioremediation are now being developed and integrated to remediate TNT-contaminated soils.

Fenton oxidation and soil washing are two alternative methods that can be used to decrease TNT levels in soil. Fenton oxidation is a process in which Fe2+ and H2O2 are added to the contaminated soil. These

reagents initiate a free-radical chemical reaction to effectively destroy TNT. This method, in order to be practical in the field, may need to be combined with other remediation processes such as soil washing. Soil washing is a method in which water is mixed with the contaminated soil to physically remove TNT. A recent study at UNL illustrated that the amount of TNT in highly contaminated soil was reduced by as much as 95% after only four soil washings. In some situations, the amount of water necessary to remove the TNT may not be economically feasible. Different approaches are necessary to completely remediate TNT- contaminated soil.

Bioremediation is an approach that is being researched for the remediation of low level TNT contamination. Bioremediation primarily uses either microorganisms or plants to break down toxic compounds. There are many indigenous populations of microorganisms that have been shown to have the capability of metabolizing TNT. However, the greater density and diversity of these organisms in the root zone of the soil can promote the reduction of TNT levels in soil. The use of plants in the remediation process is called phytoremediation. Phytoremediation of TNT has three goals: keep the TNT within the root zone, provide a suitable environment for microbial activity, and promote maximum metabolism of TNT.

Several grasses are currently growing in the area of the Nebraska Ordinance Plant, where TNT concentrations are much higher than those often included in bioremediation research. Recent studies have been conducted with three grasses: tall fescue (Festuca arundinacea Schreb.), switchgrass (Panicum virgatum L.), and smooth bromegrass (Bromus inermis Leyss.). Research was initially required to determine the tolerance of these grasses to environments containing TNT. Previous studies show that tall fescue could be established in soils with concentrations less than 100 mg TNT kg-1 soil. Switchgrass and smooth bromegrass could be established at concentrations of 50 mg TNT kg-1 soil and 25 mg TNT kg-1 soil, respectfully. However, even at these concentrations which allowed grass establishment, the top growth of tall fescue was reduced by 40%, while switchgrass top growth was decreased by 80% compared to the controls.

Because these grasses tolerated low TNT concentrations, it was necessary to determine if they can help to retain TNT in the root zone and metabolize it. Retaining TNT in the root zone is crucial because that is where it can be more effectively degraded by microorganisms. In addition, these plants may take up TNT from the root zone. Research also shows that TNT is more tightly bound in soil containing smooth bromegrass than soil with no vegetation. One of the most recent studies conducted at UNL demonstrated that smooth bromegrass has the ability to take up and metabolize TNT. Smooth bromegrass was grown in a sterile environment with no microbial populations to influence the experiment. It was shown that in soil containing 120 mg TNT kg-1 soil, over 20% of 14C-TNT was taken up and 0.03% was metabolized into 14CO2 after five days. This demonstrates a process that physically removes TNT from the soil and breaks it down into less toxic products. Phytoremediation is an important tool in the complete remediation of TNT- contaminated soils. Plants can foster microbial populations, retain TNT in the root zone, and also take up and metabolize TNT.

Information obtained from this research can also be useful in remediating soils contaminated with compounds similar to TNT. Common dinitroaniline herbicides, such as trifluralin, oryzalin, and pendimethalin, have structures similar to TNT and its initial degradation products. Some of these herbicides, like TNT, may be persistent and can pose potential environmental hazards, particularly at spill sites. It is important to evaluate all available remediation tools to develop the most cost-effective and environmentally friendly means of remediating contaminated soils. By using an integrated approach, many contaminated soils can be successfully remediated.

Editor's Note: Neil Heckman is a graduate student working with CGS Associate Garald Horst.

Why We Do What We Do

by Dick Gray, Agronomist, Nebraska Department of Roads

The Department of Roads restores between 1,500 and 2,000 acres of right-of-way per year. For the metrically inclined, that is 600 to 800 hectares. These projects all spread out from Falls City to Harrison and Haigler to South Sioux City. The soils range from Valentine's sand to some excellent prairie soils of south central Nebraska to the glaciated hills of east central Nebraska. We work with areas having very little topsoil. We do salvage and place topsoil in the sandhills, which accelerates the healing process.

The size of our operation is spread over 10,000 miles of highways and equates to 80+/- sections of grassland that we manage.

We start with a seeding mix of native and adapted grasses, forbs, and flowers. This mix has many important functions: control erosion (first priority), stabilize the soil, overcome the annual "weeds," deter the noxious weeds, catch blowing snow, trap and deteriorate litter, provide wildlife habitat, serve as an emergency hay bank, and provide color and interest while doing all of this.

What grasses and forbs can do all of these things? The natives. We have used Canada wildrye, western wheatgrass, reed canarygrass, eastern gamagrass, big bluestem, switchgrass, Indiangrass, sideoats grama, little bluestem, buffalograss, blue grama, sand bluestem, sand reedgrass, sand lovegrass, sand dropseed, lead plant, Illinois bundleflower, partridge pea, purple prairie clover, roundhead lespedeza, Blackeyed Susan, upright prairie coneflower, Grayhead prairie coneflower, shellleaf penstemon, Black Samson, wild rose, pitcher sage, Maximillian, plains coreopsis, Rocky Mt. bee plant, prickley poppy and Pennsylvania smartweed. The mix is area specific, and the varieties are specific and change with their area of adaptability.

Some of the adapted species we use are: intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, thickspike wheatgrass, tall fescue, sheeps fescue, bluegrass, sweet clover, red clover, white clover, crimson clover, hairy vetch, crown vetch, flatpea, dames rocket, blue flax, red flax, ox-eye daisy, chicory, lance leaf coreopsis, and blanket flower.

We are quite fortunate to have a large palate to select from and a seed industry that can produce the varieties we need to accomplish our tasks.

Bison Symposium Call for Papers

The University of Nebraska's Center for Great Plains Studies presents its 24th annual symposium, Bison: the Past, Present, and Future of the Great Plains, April 6-8, 2000 in Lincoln, NE. The Center invites submissions of papers, panels, and other proposals, including displays, posters, graphics, stories, dramatic presentations, and films focusing on the past, present, and future role of bison on the Plains. Topics might include but are not limited to: Bison and... Native Americans, literature, ecology, art, management, history, spirituality, politics, production, land use. Interested contributors should submit proposals of 150-200 words with a cover letter and a brief resum, by July 1, 1999. Persons whose proposals are accepted will be expected to submit final papers or projects by February 1, 2000. Great Plains Quarterly and Great Plains Research, the Center's scholarly journals, have right of first refusal on all papers presented. Submit your proposal and brief resum, by July 1, 1999 to: Charlene Porsild & Ken Winkle, Co-Chairs. Center for Great Plains Studies, U. of Nebraska, 1213 Oldfather Hall, Lincoln, NE 68588-0314, 402- 472-3082, fax: 402-472-0463, cgps@unlinfo.unl.edu, http://www.unl.edu/plains/2000symp.htm.

Prairie Restoration Seminars Available on Video

The theme of the 1998 CGS Fall Seminar Series was prairie restoration. The weekly seminars were videotaped by CGS staff and can be checked out in person or viewed in the CGS Reference Center at no charge. We will also send them to you at the cost-recovery charge of $5/video to rent or $10/video to buy. Selected seminars from other years are also available. Contact the CGS office for more information, or see http://www.grassland.unl.edu/seminars.htm.

Topics and speakers in 1998 were:

- "Evolution of the Grasslands of the Great Plains," by James Stubbendieck, UNL Center for Great Plains Studies and Agronomy Department
- "Prairie Restoration Checklist," by Glenn Pollock, Iowa Prairie Project
- "Ecology and Restoration of Sandhill Blowouts," by Charles Butterfield and Jeff Rawlinson, technologists, UNL Agronomy Department
- "True Grassland Restoration Is It Possible?" by William Laycock, former head of University of Wyoming Range Management Department
- "Restoration of Eastern Nebraska Grasslands," by Bruce Anderson, UNL Agronomy Department
- "Improving Native Legume Establishment for Prairie Restoration and Grassland Renovation," by Dan Berans, graduate student, UNL Agronomy Department
- "High Diversity Prairie and Wetland Restoration in Central Nebraska," by Bill Whitney, Prairie Plains Resource Institute
- "Prairie Restoration Now What?" by Brent Lathrop and Chris Helzer, Nebraska Chapter of The Nature Conservancy
- "Grassland/Wetland Restoration: Approaches in the Sandhills," by Gene Mack, U.S. Fish and Wildlife Service
- "Evaluation of Wet Meadow Restorations in the Platte River Valley," by Kent Pfeiffer, Platte River Whooping Crane Trust
- "Consumer Viewpoints of Prairie Restoration," by Greg Davis, UNL Horticulture Department
- "Nitrogen Cycling and the Stability of Tallgrass Prairies, by David Wedin, UNL School of Natural Resource Sciences
- "Grassland Restoration in Northern Europe: Lessons for the Midwest," by David Wedin

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CGS Associates

In October CGS Director Martin Massengale was appointed to a three-year term on the USDA National Agricultural Research, Extension, Education and Economics Advisory Board. The board, which was authorized in the 1996 Farm Bill, has 20 members from the public and private sectors.

The following awards were presented at the 1998 American Society of Agronomy/Crop Science Society of America/Soil Science Society of America meetings held in October: David Baltensperger, CSSA Fellow; Richard Ferguson, Gary Hergert, Charles Shapiro, and Ken Frank, Extension Educational Materials. Lowell Moser assumed his position as CSSA President.

In September Robert Shearman was elected Fellow of the American Association for the Advancement of Science.

David Baltensperger was also recognized at the 1998 Gamma Sigma Delta Annual Meeting at which he received the Excellence in Research Award.

The "Extra Mile" Award was presented to Fred Baxendale at the Coopreative Extension Association's annual conference in November.

Tom Franti was recognized by the University of Nebraska Agricultural Research Division for research accomplishments of junior faculty members for the 1998-99 academic year.

While you won't find her name among the list of CGS Associates in our directory, we consider Jan Shamburg our associate in terms of what she does for the CGS office. We're pleased to announce that our secretary, Jan, received the December Institute of Agriculture and Natural Resources Outstanding Employee Award.

Reminder:

The largest scientific and professional meeting dealing with grasses ever held in Nebraska will occur February 21-26,1999 when the Society for Range Management and the American Forage and Grassland Council meet in Omaha. There will be many excellent presentations and workshops to attend. Don't forget to stop by the Center for Grassland Studies exhibit table.

"...more than anything else I felt motion in the landscape; in the fresh, easy-blowing morning wind, and in the earth itself, as if the shaggy grass were a sort of loose hide, and underneath it herds of wild buffalo were galloping, galloping..." *Willa Cather, My Antonia (1918)*

Calendar

Contact the CGS for more information on these upcoming events:

1999

Feb. 21-26: Society for Range Management/American Forage and Grassland Council joint meeting, Omaha, NE
(http://srm.org/meetings.html)

Apr. 11-16: International Symposium on Nutrition of Herbivores, San Antonio, TX

Jul. 19-23: VI International Rangeland Congress, People & Rangelands: Building the Future, Townsville, Australia
(http://irc.web.unsw.edu.au)

Aug. 15-20: International Congress on Ecosystem Health - Managing for Ecosystem Health, Sacramento, CA
(http://www.vetmed.ucdavis.edu/centers/iseh/ecosystemhealth.html)

Sep. 13-17: FAO/Netherlands Conference on Multifunctional Agriculture and Land Management, The Netherlands,
http://www.fao.org/sd/agr99/

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

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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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