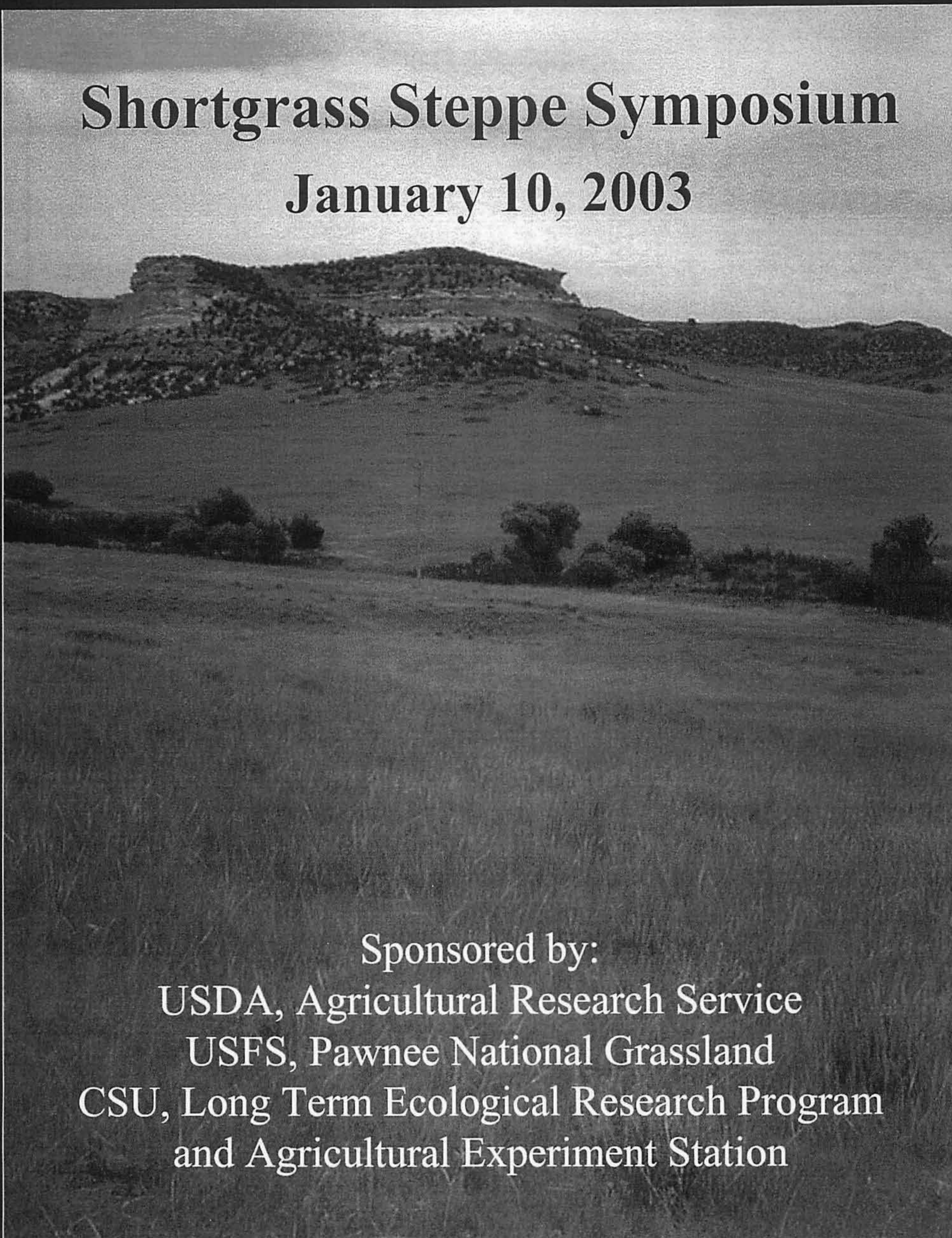
Shortgrass Steppe Symposium

January 10, 2003



Sponsored by:
USDA, Agricultural Research Service
USFS, Pawnee National Grassland
CSU, Long Term Ecological Research Program
and Agricultural Experiment Station

2003 Shortgrass Steppe Symposium
University Park Holiday Inn
January 10, 2003
Agenda

7:30	**Arrival and Poster Mounting (continental breakfast)**
8:30	**Welcome, Gene Kelly, Colorado State University**
8:45	**"Biodiversity Conservation in the Western High Plains", Greg Gamble, Northeastern Colorado Program Manager and Steve Kettler, Eastern Colorado Conservation Scientist, The Nature Conservancy of Colorado.** ***An overview of a conservation planning effort for the Western High Plains of Weld County, highlighting questions about plant, animal, and natural community conservation.***
9:30	**Poster Session**
10:30	**Break**
11:00	**Discussion of posters and how basic and applied aspects of research fit into the conservation effort.** **Discussion Leaders: Steve Currey, USDA Forest Service and Jack Morgan, Agricultural Research Service**
12:00	**Lunch and Photo Contest**
1:30	**"Species Conservation on Private Lands", Ken Morgan, Private Lands Habitat Specialist, Colorado Division of Wildlife** ***An overview of the Colorado Species Conservation Partnership, challenges facing agricultural producers, and species conservation opportunities.***
2:15	**Poster Session**
3:00	**Break**
3:30	**Discussion of posters and relationships between small-scale research and large-scale issues facing the shortgrass steppe.** **Discussion Leaders: Mike Antolin and Bill Lauenroth, Colorado State University**
4:30	**Synthesis, Jack Hautaluoma, Colorado State University**
5:00	**Adjourn to Mixer**

2003 Shortgrass Steppe Symposium Participants

Amy Yackel Adams	CSU/GDPE
Rod Adams	CSU, Department of Philosophy
Peter Adler	SGS-LTER/CSU, Rangeland Ecosystem Science
Mike Antolin	SGS-LTER/CSU, Biology
Mary Ashby	USDA/ARS, CPER
Tyler Benton	Stratton High School
Dana Blumenthal	USDA/ARS, Rangeland Resources Research Unit
Mark Brennan	Boulder County Parks and Open Space
Lisa Bryant	USDA Forest Service, Pawnee National Grassland
David L. Buckner	ESCO Associates Inc.
Indy Burke	SGS-LTER/CSU, Forest Sciences
Phil Cafaro	CSU, Department of Philosophy
Dennis Child	CSU, Department of Rangeland Ecosystem Science
Stanley Clapp	USDA/ARS, Rangeland Resources Research Unit
Sam Cox	USDA/ARS, Rangeland Resources Research Unit
Steve Currey	USDA Forest Service, Pawnee National Grassland
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Jim Detling	SGS-LTER/CSU, Biology
Jeri Dreher	SGS-LTER/CSU, Soil and Crops Sciences
Boyce Drummond	Colorado Natural Heritage Program

Bob Flynn	SGS-LTER/CSU, Soil and Crops Sciences
Pam Freeman	USDA/ARS, Rangeland Resources Research Unit
Greg Gamble	The Nature Conservancy/Northeast Colorado Program Manager
Mark Gershman	City of Boulder Open Space and Mountain Parks
Wendell Gilgert	USDA/NRCS, Wildlife Habitat Management Institute
Doug Grant	USDA/ARS, Rangeland Resources Research Unit
Niall Hanan	CSU/NREL
David Hanni	Rocky Mountain Bird Observatory
Laurel Hartley	SGS-LTER/CSU, Biology
Buffy Hastings	CSU/GDPE
Jack Hautaloma	CSU, Department of Psychology
Judy Hendryx	SGS-LTER/CSU, Soil and Crops Sciences
Jim Hunter	USDA/ARS, Soil Plant-Nutrient Research Unit
David Jensen	SGS-LTER/CSU, NREL
Sue Kamal	Colorado Native Plant Society
Nicole Kaplan	SGS-LTER/CSU, Soil and Crops Sciences
Gene Kelly	SGS-LTER/CSU, Soil and Crops Sciences
Steve Kettler	The Nature Conservancy/Conservation Scientist
Seline Koler	CSU, Department of Rangeland Ecosystem
Bill Lauenroth	SGS-LTER/CSU, Rangeland Ecosystem Science
Dan LeCain	USDA/ARS, Rangeland Resources Research Unit
Erin Lehmer (Powell)	SGS-LTER/CSU, Biology

Mark Lindquist	SGS-LTER/CSU, Soil and Crops Sciences
Petra Lowe	SGS-LTER/CSU, Forest Sciences
Maggie Marston	USDA Forest Service, Pawnee National Grassland
Cynthia Melcher	Audubon Colorado
Kim Melville	UNC, Biological Sciences
Daniel Milchunas	SGS-LTER/CSU, Rangeland Ecosystem Science
John Moore	SGS-LTER/UNC, Biological Sciences
Jack Morgan	SGS-LTER, USDA/ARS, Rangeland Resources Research Unit
Ken Morgan	Colorado Division of Wildlife/Private Lands Habitat Specialist
Marti Morgan	Senator Allard's office
Arvin Mosier	SGS-LTER, USDA/ARS, Rangeland Resources Research Unit
Moffatt Kang'iri Ngugi	CSU, NREL
John Norman	SGS-LTER/CSU, Soil and Crops Sciences
Laura O'Leary	CSU
Maureen O'Mara	SGS-LTER/CSU, Rangeland Ecosystem Science
Tom Peterson	CSU, NREL
Frances Pusateri	Colorado Division of Wildlife
Meghan Quirck	UNC, Biological Sciences
Jean Reeder	USDA/ARS, Rangeland Resources Research Unit
Lynn Riedel	City of Boulder Open Space and Mountain Parks
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Lisa Savage	SGS-LTER/CSU, Biology

Jerry Schuman	USDA/ARS, Rangeland Resources Research Unit
Dale Shaner	CSU/Dept of Bioagricultural Sciences and Pest Management
Susan K. Skagen	US Geological Survey
David Smith	USDA/ARS, Rangeland Resources Research Unit
Gericke Sommerville	CSU, NREL
Jerry Sonnenberg	Colorado Farm Bureau
Sallie Sprague	SGS-LTER/CSU, Soil and Crops Sciences
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Patty Stevens	US Geological Survey, Biological Resources Division
Jean Thomas	USDA Forest Service, Pawnee National Grassland
Jeff Thomas	USDA/ARS, CPER
Tammy VerCauteren	Rocky Mountain Bird Observatory
Phil Westra	CSU/Dept of Bioagricultural Sciences and Pest Management
Caroline Yonker	SGS-LTER/CSU, Soil and Crops Sciences

2003 Shortgrass Steppe Symposium
Poster Presentations

Peter Adler	The species-time-area relationship: adding a new dimension to an old pattern
Tyler Benton	An Ecological Study of the Efficacy of the Conservation Reserve Program: A Comparison of an Introduced Grass Mix and a Native Grass Mix
David Buckner Mark Gershman, and Lynn Riedel	Long-term Monitoring of Prairie Dog-affected Vegetation of Shortgrass sites in the Boulder Valley Area
Bob Flynn	An Information Management toolbox for the present and future to support data synthesis activities
Douglas Grant	Water Soluble Organic Carbon in Surface Soil: From Microsite to Topographic Position
Laurel Hartley	Integration of SGS-LTER Research into a K-12 Ecology Project at the Cathy Fromme Prairie
Jim Hunter	CPER Groundwater Does Not Support Complete Denitrification in Denitrifying Barriers
Nicole Kaplan	Through the Looking Glass: What do we see, What have we learned, What can we share? The History of Information Management at the Shortgrass Steppe Long Term Ecological Research Site
Selina Koler	Microchannel Erosion
Erin Lehmer (Powell)	The Relationship Between Torpor, Environment, and Body Condition in Free-Ranging Black-Tailed Prairie Dogs

Petra Lowe	Effect of humus precursors and sucrose on exotic species in a disturbed shortgrass steppe site
Petra Lowe	The effect of resource availability and microclimatic manipulation on belowground processes in shortgrass steppe
D.G. Milchunas	Decomposition of elevated CO_2-grown plant material under varying UV-B radiation exposure in shortgrass steppe
Moore, John	Changes in Nutrient Flow Influence Dynamic Stability
Moore, John	The Colorado Front Range GK-12 Project: Linking Academic Research and K-12 Education
Jack Morgan	CO_2 Enhances Productivity and Alters Species Composition of the Shortgrass Steppe
Jack Morgan	Real-Time Measurement of the Carbon Cycle on the Shortgrass Steppe
Moffatt K. Ngugi	An integrated Multi-scale Investigation of Grassland Management: Implications for Carbon Cycling
Maureen O'Mara	Ecology of Linaria Dalmatica on the Central Plains Experimental Range
Lisa Savage and Mike Antolin	The Effects of Fragmentation and Plague on the Population Genetic Structure of Black-tailed Prairie Dogs on the CPER/SGS-LTER
Dale Shaner and Philip Westra	Colorado Integrated Vegetation Management Team
Susan K. Skagen and Amy A. Yackel Adams	Population Demography of Shortgrass Prairie Songbirds
Paul Stapp	Plague outbreaks in prairie-dog colonies associated with El Niño climatic events.

The species-time-area relationship: adding a new dimension to an old pattern

P.B. Adler and W.K. Lauenroth

Graduate Degree Program in Ecology, Colorado State University, Fort Collins,
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In 1960, Preston proposed that the relationship between species number and time should be equivalent to the well-known species-area relationship. Extending the species-area relationship (SAR), one of the few laws of ecology, into the temporal dimension would have far-reaching consequences for theoretical and applied research. We used long-term data from permanent plots in Kansas grasslands to show, first, that the species-time relationship (STR) follows a power-law, as Preston predicted, with scaling exponents high relative to typical SARs. Second, we show that species number is a function of time, area, and a time-area interaction term. The interaction parameter describes decreases in the scaling exponent of the STR as area sampled increases, and decreases in the scaling exponent of the SAR as time observed increases. At all but the broadest spatial scales, well beyond the reach of field sampling, time had a strong influence on species number. Although this empirical species-time-area relationship awaits a theoretical explanation, it has profound implications for basic research and conservation biology.

AN ECOLOGICAL STUDY OF THE EFFICACY OF THE CONSERVATION RESERVE PROGRAM: A COMPARISON OF AN INTRODUCED GRASS MIX AND A NATIVE GRASS MIX.

2003 SGS SYMPOSIUM

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The purpose of this ecological project was to compare CRP that has been planted to an introduced grass mix versus a native grass mix. I (1) calculated CO2 respired by soil microbes, (2) determined percent nitrogen, carbon, and organic matter content, (3) quantified the invertebrate biomass, (4) determined above and below ground productivity, (5) and performed a range survey.

Sites were chosen, and samples obtained. Base traps were constructed, incubated, and titrated to quantify the CO2 respiration rate. Pitfall traps were assembled and placed in four-meter grids, which were plotted at each site. The insects were collected, identified and quantified. The above and belowground productivity samples were taken and weighed. The belowground productivity was ashed (to compensate for soil that could skew the results). The soil and above and below ground productivity samples were both analyzed using the LECO CHN-1000 to find the percent nitrogen and carbon. To determine the percent organic matter of the soil, the samples were weighed, placed in an oven then reweighed. The range was also surveyed to identify grass species and their percent, which were compared to the percentages of grasses seeded.

I found that although there was a slight difference between the grass mix it was not considerable. There was a small fluctuation between the CRP grasses and the native grazed rangeland. In my study I was of many variables that I was not able to control, such as the drought, and establishment of CRP fields. In summary, the plant mix does not greatly affect the availability of nutrients within the land.

Additional 2003 Shortgrass Steppe Symposium Participants

Shelley Bayard	USDA Forest Service, Rocky Mountain Research Station
Heather Blackburn	CSU, Department of Biology
Beth Dillon	
Victoria Drietz	Colorado Natural Heritage Program
Keisha Friedly	Akron High School
Cody Hardy	Akron High School
Amber Henry	High Plains High School
Howard Horton	UNC, Department of Biology
Lachlan Ingram	University of Wyoming, Department of Renewable Resources
	USDA/ARS, Rangeland Resources Research Unit
Broc Leuth	Akron High School
Peter Newman	CSU, Department of Natural Resources and Recreational Tourism
Deanna Schrock	Akron High School

Correction to printed program:

Jack Hautaluoma	CSU, Organizational Psychology

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Buckner, David L.[1], M. Gershman[2], and L. Riedel[2]. ([1]ESCO Associates Inc., [2]City of Boulder Open Space and Mountain Parks Dept.). Long-term Monitoring of Prairie Dog-affected Vegetation of Shortgrass Sites in the Boulder Valley Area.

Averaged over 1997, 1998, 1999 and 2001, total vegetation cover in prairie dog occupied sites averaged slightly greater than the unoccupied sites from 1997 through 1999, when calendar year precipitation through June averaged 45% above average. In 2001, following the drought year of 2000, the relationship had reversed. Bare soil in occupied sites has averaged about double that of unoccupied sites, while litter cover of occupied sites has averaged about one-half that of occupied sites. Native perennial warm season grasses have averaged about 20% to 33% greater absolute cover on unoccupied sites than unoccupied sites. By comparison, native perennial cool season grasses of occupied sites have averaged about one-half the cover present on unoccupied sites. Species density (no. of species per 100 sq.m.) of occupied sites have averaged about 75 to 85% that of unoccupied sites.

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Flynn, B., J. Norman, N. Kaplan, D. Beer, and A. Zeimet

An Information Management toolbox for the present and future to support data synthesis activities.

This poster displays four examples of topics and tools currently being implemented and developed by information management staff at the Shortgrass Steppe LTER, across the LTER Network and within USDA Agricultural Research Service (ARS). These tools are necessary in order to synthesize similar data sets from different researchers, agencies, and institutions. These tools were designed to provide support to Principal Investigators, educators, students, and policy makers that need to synthesize information to make better decisions about planning their research, coursework and land management strategies. The four areas to be presented are Geographical Information Systems (GIS) and Remote Sensing, standardization of metadata using Ecological Metadata Language (EML), integration of relational database management systems for different agencies, and the creation of useful dynamic web pages. GIS and Remote Sensing are powerful tools that allow researchers to analyze, model, and predict ecological factors and outcomes that shape the shortgrass steppe by integrating spatial and non-spatial data collected at the field site. EML consists of a number of modules that define an extensible mark-up language (XML) that creates a standard syntax for ecological metadata. This concept allows for sharing of standard metadata and data across not only the LTER Network, but throughout the broader ecological community. SGS is researching new database technologies to manage the growing amount of standard non-spatial data from the ARS and LTER, as well as GIS and Remote Sensed data. This also will address the need for multi-user data access and database integration with the SGS website. An SGS Website was launched 8 years ago to provide general site information as well as detailed research information. The web site will be enhanced over the next year to improve query tools, submit metadata online, improve integration with various ecological research databases, and implement the EML standards.

GIS and Remote Sensing	Metadata Standardization	Relational Database Management System	Dynamic Web Pages

IM staff at SGS-LTER continues to development tools within these four areas that support the synthesis of ecological information.

Summary for the 2003 SGS Symposium

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Grant, DW[1,2] and JD Reeder[1] ([1]USDA-ARS, [2]GDPE). **Water Soluble Organic Carbon in Surface Soil: From Microsite to Topographic Position.**

Research being conducted at the Central Plain Experimental Range (CPER) examines the relationship between water soluble organic carbon (WSOC) and topographic features. WSOC is a highly labile form of carbon and turns over rapidly compared to more recalcitrant components of soil organic matter (SOM). Microtopographic differences in surface characteristics may affect WSOC in surface soil because mineralization and moisture dynamics are influenced by microsite conditions. Topographic position also may influence WSOC levels in soil because of the strong influence of aspect on temperature and moisture, despite the subtlety of topographic features in the shortgrass steppe landscape. The objective of this research in progress is to quantify the influence of microsite and topographic position on WSOC levels in surface soils (0-5, 5-10 cm) and to examine the relationships between WSOC and soil texture, moisture, and total organic carbon. Exposed mineral soil (bare ground) had lower WSOC than *Bouteloua gracilis* occupied soil only in one of three pastures sampled at CPER in spring of 2001. Soil on South facing slopes had significantly higher WSOC than soil from flat areas. Measuring dynamic soil characteristics such as WSOC in relation to different spatial and temporal scales will help to make realistic quantifications of soil carbon balances.

Comparison of Water Soluble Organic Carbon (mg WSOC/Kg Soil) between Microsite and Aspect

Pasture Location	Bare ground	*B. gracilis*
Southeast	3.60 a	3.33 a
Southwest	3.89 a	3.26 a
Northern	2.37 b	3.24 a

Aspect	Microsites Combined
Flat	3.16 a
North Facing	3.50 ab
South Facing	4.23 b

Means followed by the same letter do not differ for microsite ($p<.10$) and for aspect ($p<.05$) for the 0-5 cm depth.

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Integration of SGS-LTER Research into a K-12 Ecology Project at the Cathy Fromme Prairie

In partnership with SGS-LTER and the City of Fort Collins, students from Rocky Mountain High School and Christa McAuliffe Elementary School are conducting research projects at the Cathy Fromme Prairie in Fort Collins. Each semester, students collect field data related to arthropod densities, microclimate in the Fossil Creek drainage, and effects of prairie dogs on the plant community. Students use protocols similar to those used at the LTER field site and are mentored by LTER scientists, NSF GK-12 Fellows, and other members of the local scientific community. Prior to collecting data, students are introduced to experimental design, plant identification, arthropod identification, use of field equipment, and concepts related to the ecology of grasslands. After collecting data, students analyze and present their results. The Cathy Fromme Project actively engages students in the scientific process and imparts the importance of long-term research. In addition, the partnership creates important links between the City of Fort Collins, K-12 schools, and research institutions.

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Hunter, WJ and R Montenieri. (Soil-Plant Nutrient Research Unit, USDA – ARS). **CPER Groundwater Does Not Support Complete Denitrification in Denitrifying Barriers.**

Nitrate in groundwater is a health and environmental hazard. Permeable denitrifying barriers are a new technology for the *in situ* remediation of nitrate-contaminated groundwaters. In deeper soils, denitrifying bacteria are usually inactive because of inadequate energy sources and denitrifying barriers function by providing an energy source. Barriers may be constructed by back-filling a trench with a mixture of sand, pea gravel, and substrate. The sand and gravel provide a porous matrix and the substrate serves as an energy source for microbial denitrifiers. This study investigated the denitrifying activity of a laboratory-scale vegetable-oil based denitrifying barrier supplied with well water from the cattle pen well at the Central Plains Experimental Range (CPER).

Water from the well next to the CPER cattle pen contained 16 to 18 ppm nitrate-N and only about 10 ppb phosphate-P. When water from this well was pumped through laboratory denitrifying columns no denitrification was observed during the first three weeks of the study. In the fourth week of the study nitrate levels in the effluent decreased slightly but significant amounts of nitrite accumulated. When supplemental phosphate was added to the well water (final concentration of 40 ppb-P, N/P = 400) and the amended water pumped into the denitrifying columns the nitrate levels in the water declined slowly over a 5 week period but again nitrite was found to accumulate in large amounts. Increasing the phosphate supplement to 80 ppb-P (N/P = 200) resulted in a gradual decline in the amount of nitrate present and a transient accumulation of large amounts of (> 5 ppm) nitrite-N. Increasing phosphate to160 ppb-P (N/P = 100) resulted in a rapid decrease in nitrate and only a brief accumulation of nitrite in the column effluents. The addition of solid rock phosphate or Biofos (5 g of either) to the denitrifying columns at the time of packing provided adequate phosphate for denitrification for a 10 week period with little accumulation of nitrite.

These results illustrate the importance of assuring that adequate phosphate is available in denitrifying barriers to prevent nitrite accumulation.

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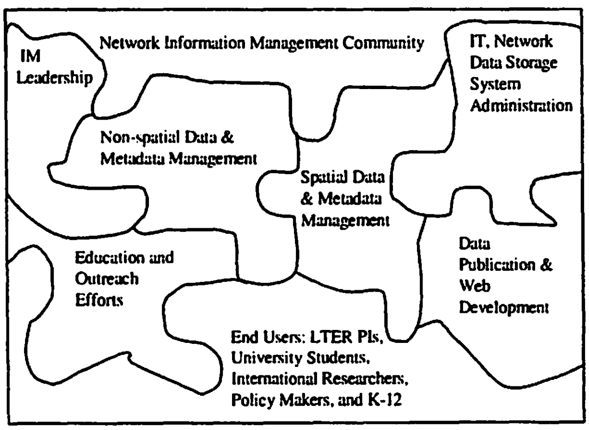
Kaplan, N., S.G. Stafford, C.W. Bennett, B. Flynn, J. Norman, D. Beer, and A. Zeimet

Through the Looking Glass: What do we see, What have we learned, What can we share? The History of Information Management at the Shortgrass Steppe Long Term Ecological Research Site

This poster documents the development of a successful information management system at a Long Term Ecological Research (LTER) site, which has a rich history of data collection and management. Over sixty years of data from three separate projects are incorporated into the Shortgrass Steppe (SGS) LTER information management system and databases. People with different strengths and expertise ranging from clerical administrator, programmer, to ecologist, have filled the role of Information Manager (IM) at the SGS-LTER. Today the information management needs of the SGS are provided by a team of IMs with various levels of expertise in a wide variety of domains from information technology administration to education and outreach. It is critical for IMs at any long-term research site to understand how information and data were managed in the past and what recent changes have been added to the system, in order to effectively implement a management plan for the future. We are able to evaluate the effectiveness of different approaches to information management and have a commitment to share our successes with the information management community.



The SGS-LTER Information Management Team includes staff members with various skills and works with IMs across the LTER Network and broader ecological research community to manage data and information about the shortgrass steppe.

2003 SGS SYMPOSIUM

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Microchannel Erosion

Approximately 4.4 billion tonnes of soil are eroded every year in the United States, resulting in $27 billion yr^{-1} in land productivity losses. These losses are important to landowners and managers, especially on arid and semiarid rangelands that are susceptible to erosion. Although studies have been conducted to assess erosion on rangelands, very little has been done to study erosion processes including microchannel formation. A microchannel is defined as any channel developed on a hill slope that is part of the network of other concentrated flow paths that function together to deliver water and sediment down the hill slope. Hypotheses that microchannels increase runoff, decrease infiltration, and increase sediment loss were tested in this field study on a shortgrass prairie. The objectives for this study were to measure runoff, infiltration, and sediment loss during a high intensity simulated rainstorm over field plots that had received three types of erosion treatments (microchannels, sheet, and no erosion). The data collected were used to determine relationships between runoff, infiltration, and sediment yield with differences in microchannels, surface cover, and roughness. Microchannel shape and sinuosity were also assessed and changes were measured following rainfall simulations. Preliminary results indicated that runoff and sediment yield were highest, with subsequent lower infiltration rates, in microchannel treated plots versus sheet erosion and no erosion treatments. Microchannel sinuosity did not change following rainfall simulations, however slight changes in channel shape were detected in the channel banks where sediment was eroded or deposited.

THE RELATIONSHIP BETWEEN TORPOR, ENVIRONMENT, AND BODY CONDITION IN FREE-RANGING BLACK-TAILED PRAIRIE DOGS (*CYNOMYS LUDOVICIANUS*)

Erin M. Lehmer
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Black-tailed prairie dogs (*Cynomys ludovicianus*) are the only ground-dwelling sciurids ranging north of 40° latitude that do not hibernate. It has been suggested that a heavy reliance on stored protein, rather than on lipid, during winter may preclude this species from hibernating. Previous studies have established that hibernators rely heavily on stored lipid during winter for energy and to maintain low body temperatures associated with torpor. It is possible that black-tailed prairie dogs lack the lipids necessary for prolonged winter dormancy. The objectives of this study were to determine body temperature patterns of black-tailed prairie dogs under natural field conditions and to elucidate the relationship between torpor, environment, and body condition in this species. I recorded the body temperatures of free-ranging adult black-tailed prairie dogs during two consecutive winter seasons in order to determine whether this species practices facultative torpor when environmental conditions are unfavorable. I also examined seasonal changes in body composition and lipid composition of the white adipose tissue and diet to elucidate patterns of energy utilization during periods of environmental and physiological stress. My results indicate that free-ranging black-tailed prairie dogs utilize a combined strategy for coping with unfavorable environmental conditions, as they continue to forage throughout winter but enter torpor in response to sudden and unfavorable changes in environmental conditions. I found that black-tailed prairie dogs rely on stored lipid during winter, as do hibernators. There was a clear relationship between white adipose tissue (WAT) lipid composition and torpor, as prairie dogs entered torpor infrequently during winter while catabolizing n-6 polyunsaturated fatty acids (PUFA) and storing n-3 PUFA. During summer, prairie dogs experience a shift in lipid metabolism, storing *n*-6 PUFA and catabolizing n-3 PUFA. These patterns of lipid deposition and use are different than those observed in free-ranging hibernators and may explain why black-tailed prairie dogs are unable to hibernate continuously throughout winter.

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Effect of humus precursors and sucrose on exotic species in a disturbed shortgrass steppe site.

Increased nitrogen availability has been shown in a variety of ecosystems to stimulate the growth of exotic, invasive plant species, to the detriment of native species. Other researchers have found that the addition of carbon amendments to the soil reduces nitrogen availability. We tested the hypothesis that adding carbon amendments in the form of humus precursors and sucrose would reduce the prevalence of exotic species, and increase native species, on a disturbed shortgrass steppe site in Colorado. We superimposed six new carbon treatments (control, sugar, lignin, sawdust, lignin and sugar, and sawdust and sugar) on a historic study site that received nitrogen, water, or the combination from 1970-1975, resulting in a dramatic increase in exotic species on the water plus nitrogen amended plots, a community change that persists into today. All of the new carbon treatments significantly reduced exotic species richness regardless of the historic treatment. The new carbon treatments, with the exception of lignin alone, reduced exotic species density by an average of 50% (Fig. 1). Our results show that the addition of carbon amendments is effective in reducing, but not eliminating, exotics species on the shortgrass steppe over a five year period.

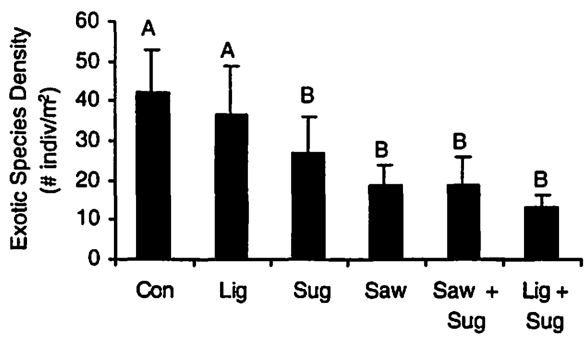

Figure 1. Effect of six carbon treatments on the density of exotic species on a historic studysite at the SGS-LTER. Columns with the same letter are not significantly different at P=0.05. Error bars are one standard error of the mean.

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The effect of resource availability and microclimatic manipulation on belowground processes in shortgrass steppe

There have been many long-term and short term experiments conducted on the shortgrass steppe which have allowed researchers to investigate the effect of resource availability and climate on aboveground ecosystem processes such as net primary production. These studies have lead researchers to consider shortgrass steppe processes as being heavily dominated by precipitation. There has been little work to date, however, involved in elucidating the effect of resource availability and microclimate on belowground processes, even though the belowground pool represents over 90% of C and N storage in this ecosystem. We initiated a new long-term study manipulating temperature, precipitation, and N availability, as well as their interactions, to investigate the effect of these manipulations on CO_2, CH_4, N_2O, and NO flux , decomposition, and nitrogen mineralization. All of the treatments increased CO_2 efflux over the control (Fig. 1). The treatments either increased or decreased the uptake of CH_4. Some of the treatments increased the efflux of N_2O and NO, while others had no effect. Efflux of NO was several orders or magnitude higher than that of N_2O over multiple treatments and years. Decomposition and nitrogen mineralization rates were significantly increased by any treatment that provided an increase in water or nitrogen availability respectively. Our results show that water availability is not the dominant influence on all belowground ecosystem processes.

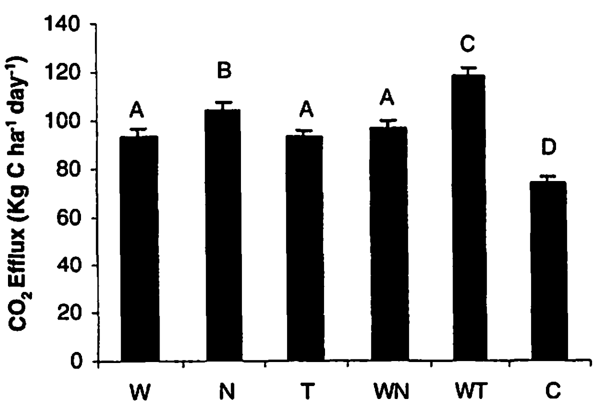

Figure 1. Effect of increased water (W), nitrogen (N), temperature (T), water and nitrogen (WN), water and temperature (WT) and control (C) on CO2 efflux from a shortgrass steppe site. Error bars are one standard error of the mean. Bars with the same letter are not significantly different at P= 0. 05

Decomposition of elevated CO2-grown plant material under varying UV-B radiation exposure in shortgrass steppe

J. Y. King, D. G. Milchunas, J. C. Moore, A. R. Mosier, J. A. Morgan, J. R. Slusser

We initiated a study in spring 2001 in the Colorado shortgrass steppe to investigate the effects of altered UV-B radiation and altered precipitation on plant growth, plant tissue decomposition, and litter faunal activity. In the field, open-air structures were constructed of solid plastic sheet material that either passed all wavelengths of solar radiation or passed all wavelengths except for UV-B (280-315 nm). Litterbags containing CO_2-grown plant tissue of different quality were placed under some of the structures to monitor decomposition and soil fauna. Additional structures were used to monitor plant productivity, tissue quality, and species composition in response to grazing treatments and UV-B exposure. Precipitation under all structures was applied by manual watering, and two levels were maintained to simulate high precipitation or drought conditions.

Preliminary results indicate slight reductions in warm-season grass production under elevated UV-B. However, neither total plant productivity nor tissue quality was significantly altered by changes in UV-B levels. Simulated grazing increased plant production. Litter decomposition was affected by level of UV radiation exposure, the CO_2 conditions it was grown under, and level of precipitation, but there were no interactions. Plant litter decomposed under structures that block UV-B radiation tended to have lower lignin content, but other fiber components (cell solubles, hemicellulose, and cellulose) were not significantly affected. Plant litter decomposed under above average precipitation tended to have higher lignin content and lower hemicellulose and cellulose content compared to the dry treatment. The density of litter arthropods was higher under reduced UV-B radiation conditions, but fungi did not appear to be affected by UV-B level or precipitation treatment.

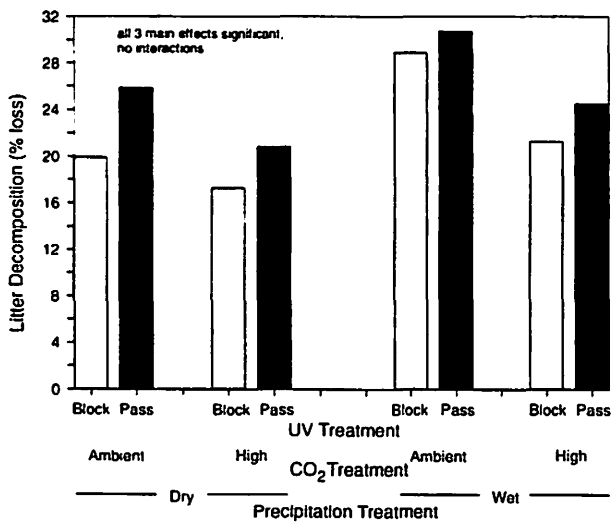

Fig. Decomposition of aboveground plant material grown under ambient or high CO_2 treatment and exposed to UV pass or block treatment for a simulated dry or wet year.

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Changes in Nutrient Flow Influence Dynamic Stability

The soil food webs are compartmentalized into three interactive pathways – the root, bacterial and fungal energy channels. Empirical studies at the shortgrass steppe and elsewhere have demonstrated that disturbance can induce changes in the relative flow of nutrients through these pathways and nutrient retention (Figure 1). Theoretical studies indicate that the compartmentalized structures are stable and that altering these structures by changing the relative flows of nutrients leads to instabilities. We present a framework that integrates, trophic structure, the nutrient flow and dynamic stability. We demonstrate that the observed trophic structures at the shortgrass steppe and elsewhere are indeed stable, and that changes in the relative flow of nutrients through the webs leads to instability (Figure 2). Figure 1 represents simplified bacterial and fungal energy channels of a soil food web. Changes in the C:N ratio of the detritus, NPP, or rates of N mineralization have been associated with shifts in the relative dominance of one channel to the other (adapted from Moore et al. 2003). Figure 2 represents simulations where the relative proportions of nutrients through the fungal and bacterial channels were altered. Stability is indexed by the most negative eigenvalue, λ. The more stable region occurs when neither the bacterial or fungal energy channel is dominant.

Figure 1

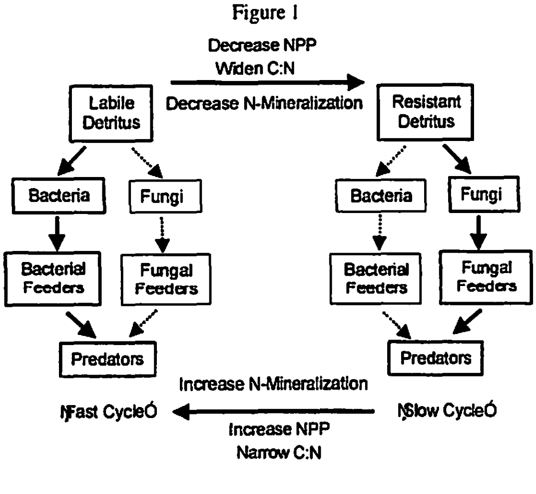
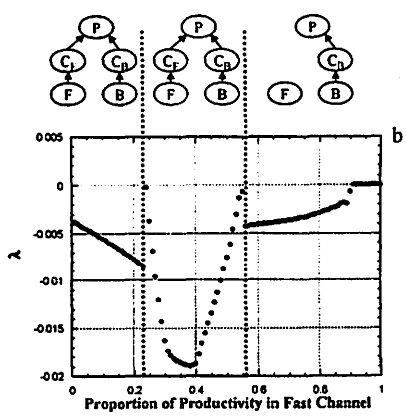


Figure 2



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The Colorado Front Range GK-12 Project: Linking Academic Research and K-12 Education.

The Colorado Front Range GK-12 Project is supported by the National Science Foundation and is a collaborative effort between The University of Northern Colorado, Colorado State University, Greeley District 6 School District, and the Poudre R1 School District. This project places graduate and undergraduate student fellows into the K-12 classroom and provides research experiences to K-12 teachers. Research conducted by teachers and fellows is related to human impacts on landuse and ecosystem structure and function along the Front Range of Northern Colorado. This theme offers rich experiences in science and math that include atmospheric science, soil science, agronomy, ecology, hydrology, computer science, and systems modeling. The main goals of the project are to: integrate real and current research into math and science education; provide research experiences for K-12 teachers; train graduate student fellows to be good educators; develop K-12 curricula that are based on research and tied to state and national education standards; and to create ties between school districts and research institutions.

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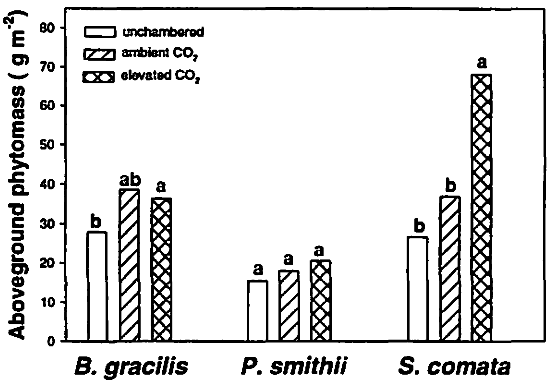
Morgan, JA, Mosier, AR, LeCain, DR, Milchunas, DG, Nelson, JA, and Parton, WJ.
"CO_2 Enhances Productivity and Alters Species Composition of the Shortgrass Steppe"

While there are still uncertainties concerning how much climate will be affected by rising atmospheric CO_2, there is no dispute that increasing atmospheric CO_2 is expected to have especially strong impacts on water-limited regions like rangelands, and may alter some rangelands sufficiently to affect long-established grazing practices. Here we report on the findings of a long-term field study conducted at the USDA-ARS Central Plains Experimental Range in north-eastern Colorado, north of Nunn, to evaluate ecological responses of a shortgrass steppe to a doubling of CO_2 over present-day concentrations.



2001 was the fifth and final year of this study. We found that over the course of the study, doubling CO_2 increased production of this grassland by 30 -50% in any one year, but most of that production increase occurred in needle-and-thread grass (*Stipa comata*: see figure). Forage digestibility declined in all three species under elevated CO_2 (data not shown), and was least in the only dominant species that showed a production increase under elevated CO_2, *Stipa comata*. Production remained unchanged in two other important perennial grasses, blue grama (*Bouteloua gracilis*), the dominant warm-season grass of the shortgrass steppe, and western wheatgrass (*Pascopyrum smithii*), an important cool-season forage.

The results indicate 1) production on the shortgrass steppe may be greater in a future CO_2-enriched world, due primarily to responses of *Stipa comata*, a low-quality forage, and 2) forage quality of most species may decline in response to growth at elevated CO_2 atmospheres. These findings are significant, as they suggest the shortgrass steppe may become more productive, but less useful as a source of forage for livestock. The results also suggest the species balance could shift away from blue grama, an important species not only in terms of its high forage quality, but also as a species that brings stability to the shortgrass steppe. Blue grama was the only notable plant species growing in some areas of the western Great Plains after the dust bowl of the 1930's. A reduced presence of blue grama could significantly reduce the stability of the shortgrass steppe.

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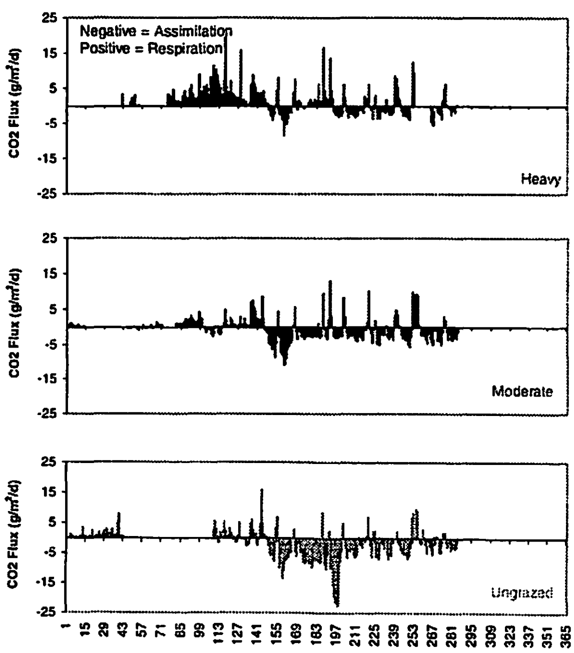
Morgan, JA, Smith, DP, LeCain, DR, Reeder JD, and G.E. Schuman. "**Real-Time Measurement of the Carbon Cycle on the Shortgrass Steppe**"

The problem of increasing atmospheric CO_2 has stimulated a prodigious research effort world-wide to elucidate the C cycle in hopes of developing management practices to reduce the rate of CO_2 build-up, thereby mitigating global climate change. One major problem interpreting many relevant C cycle experiments has been evaluating soil C responses to treatments. Depending on the particular treatment, several years to several decades may be required before soil C levels respond sufficiently to be detected. Since temperature and water can have strong effects on many aspects of the C cycle, any interpretation of soil-based C measurements to multi-year treatments are confounded by year-to-year variability in weather. Further, most researchers do not have the luxury of waiting 10 to 25 years for newly-imposed treatments to yield detectable soil C responses. In recent years, off-the-shelf micrometeorological gas exchange systems have become available to ecological scientists, offering almost real-time measurements of net ecosystem C exchange. Such gas exchange systems allow continuous monitoring of net ecosystem fluxes of CO_2, and thus offer an alternative to soil C analyses for evaluating system C responses.

Here we report some preliminary findings from a Bowen ratio/energy balance micrometeorological system for CO_2 flux measurements conducted at the USDA-ARS Central Plains Experimental Range to investigate the effect of heavy grazing by cattle (75% forage removal) vs. the recommended grazing pressure (40% removal) and an ungrazed pasture. The study was begun in 2001, and will continue through 2005. The years 2000-2002 mark a period of major drought for the region. In 2001, precipitation was 80% of the long-term average, but there was no detectable effect of grazing intensity on C flux (data not shown). These null responses are characteristic of previous work that has shown little to no significant effects of stocking rate on seasonal CO_2 fluxes. However, a different picture emerged in 2002. Precipitation was only about 50% of average in 2002, and as a result, cattle were removed from the pastures in mid-July. Nevertheless, CO_2 exchange was strongly affected by grazing treatment (see figure). Net CO_2 assimilation was lowest in the heavily grazed pasture, and highest in the ungrazed pasture; CO_2 assimilation in the moderately grazed pasture was intermediate between the other two treatments. Heavy grazing seemed to cause a net loss of C from the ecosystem. These results suggest that while the SGS may be resilient in the long-term to grazing, in the short-term, livestock removal or reductions in stocking rate may be important for maintaining a positive C balance in the face of drought.

2002 Bowen Ratio CO_2 FLUX



2003 SGS SYMPOSIUM

Summary:
An Integrated Multi-scale Investigation of Grassland Management: Implications for Carbon Cycling

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Altering grassland management is a potentially important tool for sequestering atmospheric C in soils. Unfortunately, information about grassland management, rangeland condition, or rangeland deterioration, has been quantified only using large-scale surveys. These data are useful as a first approximation of land management change at any particular location, but changes are not discernible directly, and net rather than gross change is typically evaluated. Remotely sensed data are spatially explicit, broad in extent, uniform for the entire area sampled, repeatable over time, and capable of appraising the entire landscape and allow incorporation of more detailed information into regional analyses of C dynamics. The research proposed here will address the need for broad-based assessment of grassland management.

The main hypothesis underlying this research is that grassland grazing management is detectable through remote sensing of biophysical responses to management. The immediate effect of removing aboveground biomass through grazing is to reduce LAI and APAR, both of which are important components for estimating net primary production (NPP) using remote sensing. Four intensive field sites in different climatic regions, each with a number of different grazing management treatments, have been established as intensive study sites; CPER is one or our sites.. Light-use-efficiency, LAI, and APAR will be quantified using ground-based measurements and related to NPP measured via clipping. These relationships will then be used to estimate NPP using remotely sensed measurements from Landsat imagery and scaled up to the more frequent and less expensive MODIS imagery. Comprehensive study sites containing adjacent sites with differing grazing intensity/history located across the Great Plains will be used to derive methods of assessing range condition and grazing intensity using MODIS and LANDSAT data. Temporal trends in range condition will be assessed in a similar manner using NALC data. Information on NPP derived from remotely sensed data will be used to drive the Century soil organic matter model to assess impacts of grassland management on soil carbon and carbon sequestration.

Ecology of Linaria Dalmatica on the Central Plains Experimental Range

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Linaria dalmatica, an exotic introduced into North America as an ornamental plant in the late 1800's, has escaped cultivation and become invasive in crop, rangeland and wilderness areas across western North America. The shortgrass steppe is one of the few environments proven inhospitable to most invasive species, presumably due to low rainfall, high evaporative demand and high summer temperatures. However, six patches of *L. dalmatica* were found on the Central Plains Experimental Research station (CPER) in 1999. A survey of *L. dalmatica* in 2000 showed 26 patches with 9 additional patches in 2001.

For my Master's research I am studying the ecology of *L. dalmatica* on the shortgrass steppe using population biology and genetic techniques to assess whether this is a species that will become invasive on the CPER. I am examining the effect of abiotic conditions and competition on the establishment and spread of *L. dalmatica* on the shortgrass steppe to determine if differences in water and nitrogen availability, and simulated grazing of competitors facilitate invasion. *Linaria dalmatica* performance will be measured with biomass measurements such as plant height, stem diameter and dry weight.

Both nitrogen and water are limiting for aboveground net primary productivity (ANPP) on the shortgrass; I am testing *L. dalmatica's* response to water and nitrogen additions. Grazing has played a large role in shaping the ecology and evolution of the shortgrass steppe. To test the effects of grazing on the population ecology of *L. dalmatica* I simulated grazing by clipping the dominant grass, *Bouteloua gracilis*. Using measurements of biomass, stem, flower and seed production I will determine the effects of water and nitrogen additions and clipping.

Finally, I am exploring both the intra- and inter-patch relatedness of *L. dalmatica* on the CPER and surrounding areas through a simple genotyping approach (inter simple sequence repeats – ISSR). I will determine similarity of *L. dalmatica* on the CPER to surrounding populations. These data will also allow me to assess whether most spread occurs through sexual reproduction or clonal growth. Determination of relatedness may also elucidate directions of movement of *L. dalmatica* on the CPER.

The Effects of Fragmentation and Plague on the Population Genetic Structure of Black-tailed Prairie Dogs on the CPER/SGS-LTER

Lisa Savage and Mike Antolin
Biology Department
Colorado State University

Black-tailed prairie dog populations have declined dramatically over the past century and now occupy less than 2% of their original habitat. These declines are not only caused by habitat destruction and eradication efforts but also by the introduction of the sylvatic plague, *Yersinia pestis*, which causes almost 100% mortality in black-tailed prairie dog colonies. Due to these factors, populations have become fragmented, involving both a decrease in population size and an increase in population isolation. In areas with the plague, such as the CPER/SGS-LTER, populations also experience metapopulation dynamics by undergoing regular local extinction and recolonization. The genetic outcome of these processes has not been well documented. The objective of this study is to delineate the relationship between genetic variability and both fragmentation and metapopulation dynamics on the CPER/SGS-LTER.

To better understand the effects of fragmentation and plague on the population genetic structure of black-tailed prairie dogs over time, we live-trapped prairie dogs on six colonies on the CPER/SGS-LTER in 2000 and 2001. With the addition of genetic data from previous work (Roach et al., 2001), we now have a three-year time series to observe how the genetics of these colonies changes over time. Additionally, between June 2000 and June 2001 we live-trapped prairie dogs along two gradients of isolation: the first in the mixed-grass prairie of Southwestern South Dakota, where there is no historic evidence of plague epizootics, and the second in the short-grass prairie of Northern Colorado, where plague has been regularly documented. In South Dakota we sampled black-tailed prairie dog colonies in Buffalo Gap National Grasslands, which has a large, well-connected population of prairie dogs, and in Wind Cave National Park, which has a naturally fragmented population of prairie dogs because of the topography of the park. Neither of these populations cycle because of plague outbreaks. In Colorado we sampled two fragmented populations of prairie dogs in the city of Fort Collins and on the CPER/SGS-LTER both of which experience metapopulation dynamics because of plague.

Genetic variability within and among populations has been measured using six microsatellite (simple sequence repetitive DNA) loci markers, and one mitochondrial control region marker. Cluster analysis of data from the genetic markers reveal patterns of relatedness among populations that can be compared to spatial data compiled in a Geographic Information System (GIS).

We found that fragmented populations of black-tailed prairie dogs show significantly higher levels of genetic differentiation than unfragmented populations (the Fst for Buffalo Gap National Grasslands is significantly lower than all other study sites) and that fragmented sites that undergo metapopulation dynamics have higher levels of genetic differentiation than the unfragmented site that does not cycle because of the plague (see Figure 1). The Fort Collins population, while showing the same trend, is not significantly different than Wind Cave National Park. We also found that over time, genetic differentiation between colonies on the CPER/SGS-LTER decreased over time (see Figure 2) in colonies that did not experience extinctions from the plague during the sampling period. Thus, prairie dogs in Colorado are functioning as metapopulations, but gene flow between colonies is high enough to decrease differentiation between plague epizootics. This data suggests that plague and fragmentation both act to increase genetic differentiation, but that populations with adequate connectivity will experience significant gene flow between populations that will act to decrease differentiation over time.

Figure 1. Levels of Genetic Differentiation among Black-tailed Prairie Dog Colonies in South Dakota and Colorado

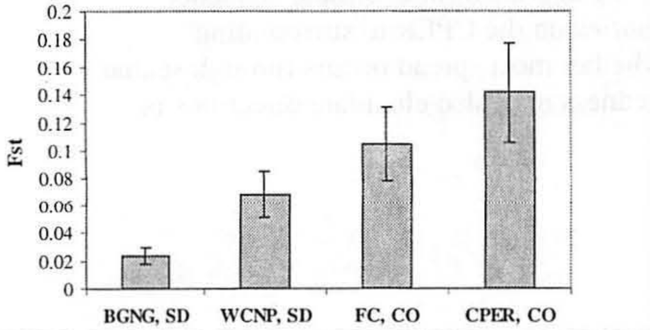
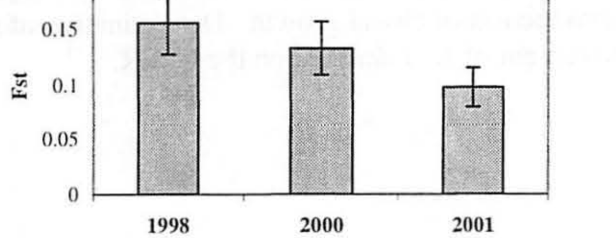


Figure 2. Levels of Genetic Differentiation among Black-tailed Prairie Dog Colonies on the CPER/SGS-LTER



Roach, J. L., P.Stapp, B.Van Horne, and M. Antolin. Genetic Structure of a metapopulation of black-tailed prairie dogs. *Journal of Mammalogy*, 82(4), 946-959, 2001.

Colorado Integrated Vegetation Management Team

Dale Shaner, Dana Blumenthal, and Philip Westra
USDA/ARS and Colorado State University

Abstract: A group of scientists from Colorado have forged a research and technology transfer alliance to address issues of vegetation management and weed control in crop land, non-cropland, or other ecosystems where invasive plants compromise the productivity and sustainability of the diverse ecosystems present in Colorado. Crop-weed management, restoration ecology, remote sensing of invasive weeds, biological control of weeds, and weed biology represent some of the current research efforts of this team. The team has written several grant proposals with the purpose of developing research projects to involve the skills and talents of all team members.

The team **Mission Statement** is to provide fundamental and applied knowledge for integrated management of invasive weeds in crops, rangelands, recreational, and natural areas to preserve the natural environment and to maintain a safe and abundant food supply. The team **Vision** is to become an internationally recognized leading center for research, education, and outreach on invasive weeds across crop and non-crop habitats.

The team is in the process of applying for status as a center at Colorado State University. The proposed center name is **Partnership for Restoration and Invasive Species Management (PRISM).** PRISM will be a multi-disciplinary research, teaching, and technology transfer center dedicated to the study and management of invasive weeds. PRISM will coordinate programs of invasive plants management agencies so as to avoid wasteful duplication and to provide a means of constructively working together.

POPULATION DEMOGRAPHY OF SHORTGRASS PRAIRIE SONGBIRDS

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We are examining population demography of declining grassland birds of the central shortgrass prairie in an effort to elucidate possible causes of population declines. We are interested in determining if observed population declines are due to constraints during the breeding season or at other times of the year. Ultimately, we will apply demographic models to our data to determine if prairie habitats in northeastern Colorado function as sources or sinks for breeding populations. During the past several years (1997-2002), we have surveyed grassland birds, measured landscape metrics and vegetation structure, estimated survival of natural and artificial nests, estimated post-fledging survival of juvenile birds until parental independence, and measured annual fecundity. Collectively, this work was conducted across 54 randomly-selected sites in variegated (62% grassland remaining; northern Weld County, Colorado) and highly fragmented (38% grassland remaining; Washington County, Colorado) landscapes.

Preliminary findings are as follows.

- We found no evidence of area sensitivity (bird density relative to area of grassland patch) of Lark Buntings (*Calamospiza melancorys*) or Horned Larks (*Eremophila alpestris*). Area sensitivity exhibited by Grasshopper Sparrows (*Ammodramus savannarum*) and Western Meadowlarks (*Sturnella neglecta*) was opposite of our expectations based on findings in other prairie landscapes. Smaller grassland patches in the highly fragmented landscape hosted greater densities of these two species.

- In general, birds occurred at greater densities and had higher nest success in the variegated landscape than in the highly fragmented landscape. Average nest success of Lark Buntings was 20-30% in northern Weld County and 8% in Washington County. This is in contrast with ca. 50% nest success in eastern Montana, a region where populations of Lark Buntings are increasing.

- Fragmentation influenced nest success as measured by artificial nest experiments. In the variegated landscape, daily survival of artificial nests was lower in 'fragmented' than in 'intact' grassland sites. Similarly, daily survival of artificial nests in the highly fragmented landscape was also positively associated with patch size.

- Survival of natural nests (Lark Buntings and Horned Larks) showed the opposite trend as the artificial nests. In the highly fragmented landscape, survival of Lark Bunting and Horned Lark nests decreased significantly with increasing patch size. We hypothesize that prairie fragmentation has differential effects on predator species, resulting in different primary predators in habitat patches of varying sizes and in landscapes differing in the extent of fragmentation. Throughout our study region, predation was the primary cause of mortality of eggs, nestlings, and fledgling birds.

- We used radio telemetry to quantify post-fledging pre-independence survival of Lark Buntings on the Pawnee National Grassland in northern Weld County, Colorado. Post-fledging survival during the first three weeks was 0.367, 0.190, and 0.120 in 2000, 2001, 2002, respectively. These findings suggest that the current indirect estimate of annual juvenile survival used in many demographic models (0.31) is too high. Currently, no other post-fledging survival estimates are available for grassland songbirds.

- High mortality occurs during the first few days out of the nest. In both 2001 and 2002, survival estimates on the first day postfledging were 0.671 and 0.684.

2003 SGS SYMPOSIUM

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Stapp, P[1,2], MF Antolin[1,3], and M Ball[4] ([1]Shortgrass Steppe Long-Term Ecological Research Project, Colorado State University, [2]Department of Biological Science, California State University, Fullerton, [3]Department of Biology, Colorado State University, [4] Pawnee National Grasslands, USDA Forest Service). Plague outbreaks in prairie-dog colonies associated with El Niño climatic events.

Plague (*Yersinia pestis*) was introduced to the western U.S. in the mid-20th century and, in addition to being an emerging human health problem, represents a major threat to persistence of black-tailed prairie dog (*Cynomys ludovicianus)* populations. Human cases of plague have been associated with weather patterns believed to be favorable to flea vector or rodent host populations, but the link between plague outbreaks in natural populations and climatic events has not been established. Using 21 years of records from an ongoing program to monitor the status and size of prairie-dog colonies on the Pawnee National Grasslands, we show that major outbreaks of plague coincided with episodic El Niño climatic events (Fig. 1), periods of unusually mild winter conditions in north-central Colorado. Furthermore, we provide evidence that larger colonies (>15 ha) are more susceptible to extinction from plague than all but the tiniest colonies, presumably because large colonies support higher population densities and thus, higher potential rates of transmission. The effects of plague in prairie-dog metapopulations therefore run counter to one common assumption of metapopulation biology: that large colonies/patches should be *less*, not more, vulnerable to extinction. There was no relationship between the probability of extinction and colony isolation, as measured by nearest-neighbor distance; however, colonies were more likely to suffer extinction if their neighbors also went extinct. This suggests some spatial patterning to plague transmission but that linear distance between colonies may be less important than other, more ecologically relevant measures of colony isolation.

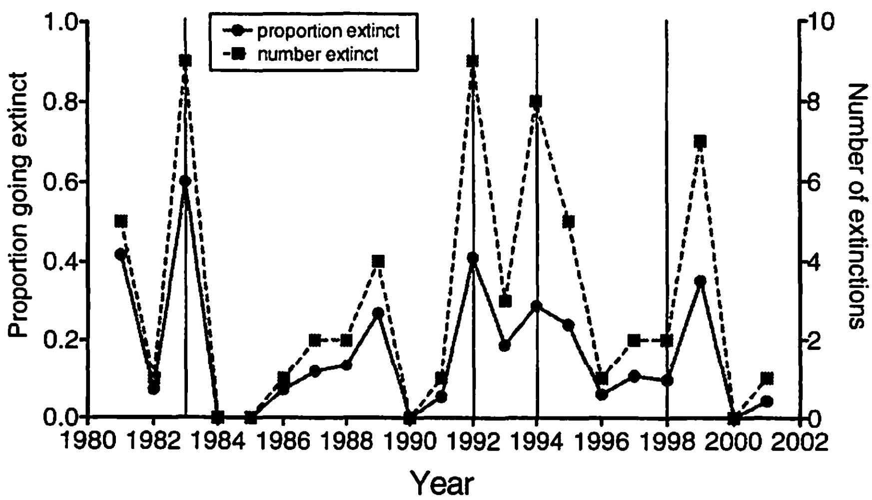

Fig. 1. Number and proportion of black-tailed prairie dog colonies that went extinct on the Pawnee National Grasslands, Colorado, between 1981 and 2001. Vertical lines indicate El Niño years.

2003 Shortgrass Steppe Symposium
Acronym Definitions

AES	Agricultural Experiment Station
ARS	Agricultural Research Service
CDOW	Colorado Division of Wildlife
CNHP	Colorado Natural Heritage Program
CPER	Central Plains Experimental Range
CSU	Colorado State University
FS	Forest Service
GDPE	Graduate Degree Program in Ecology
NRCS	Natural Resources Conservation Service
NREL	Natural Resource Ecology Laboratory
NSF	National Science Foundation
PNG	Pawnee National Grassland
RMBO	Rocky Mountain Bird Observatory
RRRU	Rangeland Resources Research Unit
SGS-LTER	Shortgrass Steppe Long Term Ecological Research
TNC	The Nature Conservancy
UNC	University of Northern Colorado
USDA	United States Department of Agriculture
USGS	United States Geological Survey

POSTER SET UP LIST

A = morning session in the TX rm
P = afternoon session in the OK rm

Morning Session (AM)	Author(s)	Poster Title
1A	Jean Reeder	Response of organic and inorganic carbon and nitrogen stocks to historic grazing management of the shortgrass steppe
2A		
3A	Tyler Benton	An Ecological Study of the Efficacy of the Conservation Reserve Program: A Comparison of an Introduced Grass Mix and a Native Grass Mix
4A	Thomas Peterson, Niall Hanan, Jack Morgan, Jean Reeder, Indy Burke, and Keith Paustian	Carbon, Water and Land-use in Conservation Reserve Program Lands of the Shortgrass Steppe
5A	Dale Shaner and Philip Westra	Colorado Integrated Vegetation Management Team
6A		
7A	Peter Adler	The species-time-area relationship: adding a new dimension to an old pattern
8A		
9A	Paul Stapp	Plague outbreaks in prairie-dog colonies associated with El Niño climatic events.
10A		
11A	Lisa Savage and Mike Antolin	The Effects of Fragmentation and Plague on the Population Genetic Structure of Black-tailed Prairie Dogs on the CPER/SGS-LTER
12A	Erin Lehmer (Powell)	The Relationship Between Torpor, Environment, and Body Condition in Free-Ranging Black-Tailed Prairie Dogs
13A	David Buckner, Mark Gershman, and Lynn Riedel	Long-term Monitoring of Prairie Dog-affected Vegetation of Shortgrass sites in Boulder Valley area
14A		
15A	Broc Leath	
16A	Susan K. Skagen and Amy A. Yackel Adams	Population Demography of Shortgrass Prairie Songbirds
17A	John Moore	The Colorado Front Range GK-12 Project Linking Academic Research and K-12 Education
18A	John Moore	Changes in Nutrient Flow Influence Dynamic Stability
19A	Laurel Hartley	Integration of SGS-LTER Research into a K-12 Ecology Project at the Cathy Fromme Prairie
20A	Gene Kelly, et al.	Shortgrass Steppe Long Term Ecological Research

Afternoon Session (PM)	Author(s)	Poster Title
1P	Bob Flynn	An Information Management toolbox for the present and future to support data synthesis activities
2P	Nicole Kaplan	Through the Looking Glass: What do we see, What have we learned, What can we share? The History of Information Management at the Shortgrass Steppe Long Term Ecological Research Site
3P		
4P		
5P	Jack Morgan	CO_2 Enhances Productivity and Alters Species Composition of the Shortgrass Steppe
6P	Jack Morgan	Real-Time Measurement of the Carbon Cycle on the Shortgrass Steppe
7P &8P	D. G. Milchunas	Decomposition of elevated CO_2-grown plant material under varying UV-B radiation exposure in shortgrass steppe
9P	Douglas Grant	Water Soluble Organic Carbon in Surface Soil: From Microsite to Topographic Position
10P	Jim Hunter	CPER Groundwater Does Not Support Complete Denitrification in Denitrifying Barriers
11P		
12P	Selina Koler	Microchannel Erosion
13P		
14P	Moffatt K. Ngugi	An integrated Multi-scale Investigation of Grassland Management: Implications for Carbon Cycling
15P		
16P		
17P		
18P	Maureen O'Mara	Ecology of Linaria Dalmatica on the Central Plains Experimental Range
19P	Petra Lowe	Effect of humus precursors and sucrose on exotic species in a disturbed shortgrass steppe site
20P	Petra Lowe	The effect of resource availability and microclimatic manipulation on belowground processes in shortgrass steppe

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Thomas Peterson[1], Niall Hanan[1], Jack Morgan[2], Jean Reeder[2], Indy Burke[3], and Keith Paustian[1] ([1]Natural Resource Ecology Laboratory, CSU, [2]Agricultural Research Service, [3]Department of Forest Sciences, CSU). Carbon, water and land-use in Conservation Reserve Program Lands of the Shortgrass Steppe.

Agricultural practices in the Great Plains have the potential to produce rapid changes in land-use across the region. The USDA Conservation Reserve Program (CRP) has active contracts on more than 2 million acres in the shortgrass prairie region of Eastern Colorado alone and equally large, or larger, areas of CRP exist in the other Great Plains States. In the next few years, many CRP contracts will come to an end and subsequent changes in management will likely alter vegetation structure and phenology in ways that will impact both the timing and intensity of short-term carbon, water and energy exchange and long-term carbon sequestration and hydrologic balance. The impacts of vegetation type on surface energy and water balance further impact atmospheric boundary layer processes, with consequent effects on weather systems and potential feedback on vegetation growth and biogeochemistry.

We are preparing an experiment in CRP land of eastern Colorado focused on the impact of land-use change (conversion of CRP land to grazing and minimum-till agriculture) on carbon, water and energy dynamics. Three eddy covariance systems, that measure gaseous exchanges above the vegetation, will be established in three adjacent, quarter-section (160 ac, for a total of 480 ac) parcels of CRP land that have been in the Program for approximately 10 years. After an initial comparison period (3-6 months), one parcel will be opened to cattle grazing at moderate intensity, a second parcel will be converted to minimum-till agriculture, while the third parcel will remain in CRP. The project will be closely linked to several existing research programs at the Shortgrass Steppe Long-term Ecological Research (SGS-LTER) site and the adjacent Central Plains Experimental Range (CPER). In addition, we will make measurements of net primary production and long-term changes in carbon stocks in soils and vegetation in the CRP treatments. These measurements will be used to infer carbon sequestration and liberation rates by a mass balance approach. The combination of long-term flux measurements with comprehensive mass balance measurements will provide separate and independent measurements of sequestration rates and processes. The field measurement program will also be coupled with detailed biosphere-atmosphere exchange modeling to simulate vegetation dynamics and biogeochemistry, land surface-atmosphere interactions and atmospheric dynamics. The modeling component will provide a powerful tool for scenario testing to explore the impact of land-use changes on carbon and water dynamics in the coupled biosphere-atmosphere system of the Great Plains region.

SUMMARY EXAMPLE: 2003 SGS SYMPOSIUM

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The shortgrass steppe (SGS) LTER is part of the network of long-term research sites across the country and around the world supported by the National Science Foundation.

Our conceptual framework asserts that SGS ecological structure and function are governed by climate, natural disturbance, physiography, human use and biotic interactions. SGS LTER work is divided into: Population Dynamics, Biogeochemical Dynamics and Land-Atmosphere Interactions. Disturbances are of such importance that they are embedded in each of these topic areas. Additionally, the SGS-LTER is involved in several cross-site experiments as well as education outreach work.

Determinants of SGS Structure and Function:

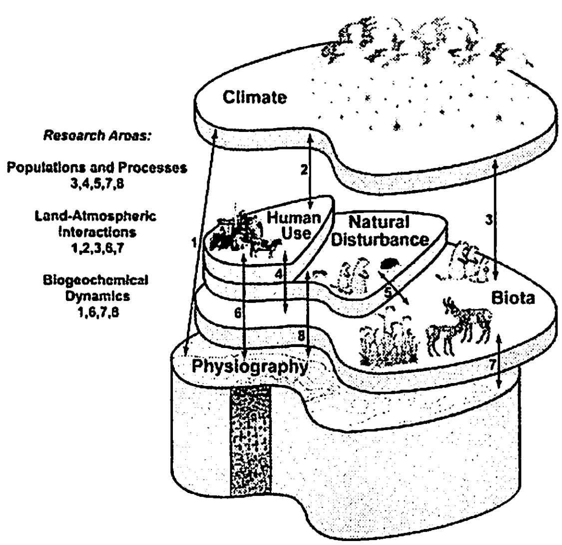

Figure 1. Conceptual representation of the determinants of SGS structure and function that guide our research.

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Reeder, J.D.[1], G.E. Schuman[2], J.A. Morgan[1] and D.R. LeCain[1] ([1]Crops Research Laboratory, Ft. Collins CO, [2] USDA-ARS High Plains Grassland Research Station, Cheyenne WY). **Response of Organic and Inorganic Carbon and Nitrogen Stocks to Historic Grazing Management of the Shortgrass Steppe.**

We investigated the impact of 57 years of grazing management on the organic and inorganic carbon (C) and nitrogen (N) contents of the plant:soil system (to 90 cm) of shortgrass steppe at the Central Plains Experimental Range, Nunn CO. Grazing treatments included continuous season-long grazing by yearling heifers at heavy and light stocking rates, and non-grazed exclosures. The heavy stocking rate resulted in a plant community dominated by blue grama (*Bouteloua gracilis,* 75% of biomass production), whereas excluding livestock grazing increased the production of annual forbs and grasses. Grazing intensity did not affect the content or distribution of organic N in the soil profile, and had only a small effect on soil organic C (SOC), with 3.8 Mg ha^{-1} more SOC in the 15-30 cm depth of the soil profile under heavy grazing compared to light or no grazing. Although SOC was fairly resistant to change by grazing management, grazing intensity strongly influenced soil inorganic C (SIC) content. Total soil C was significantly higher (23.8 Mg ha^{-1}) in the soil profile (0-90 cm) under long-term heavy grazing compared to long-term light grazing or exclusion of grazing, with 68% (16.3 Mg ha^{-1}) attributed to an increase in IC, and 32% (7.5 Mg ha^{-1}) due to an increase in OC. Future studies to evaluate stable C isotopic composition of SIC and SOC will help elucidate the sources of the increased SIC in the soil profile of the heavily grazed treatment. We hypothesize that the observed increase in SIC with heavy grazing is a combination of newly sequestered C and redistributed SIC from deeper in the soil profile.

Soil Inorganic C, Mg ha^{-1}

	--------- Pasture 23W --------		---------- Pasture 23E ----------	
Depth, cm	Lightly Grazed	Exclosure	Heavily Grazed	Exclosure
0 – 15	0.32	0.14	0.06	0.05
15 – 30	0.40	0.17	2.18	0.05
30 – 45	0.35	0.22	5.38	1.12
45 – 60	0.39	0.25	14.52	7.33
60 - 90	8.53	6.01	19.38	16.63
Total SIC	9.99	6.79	41.52	25.18