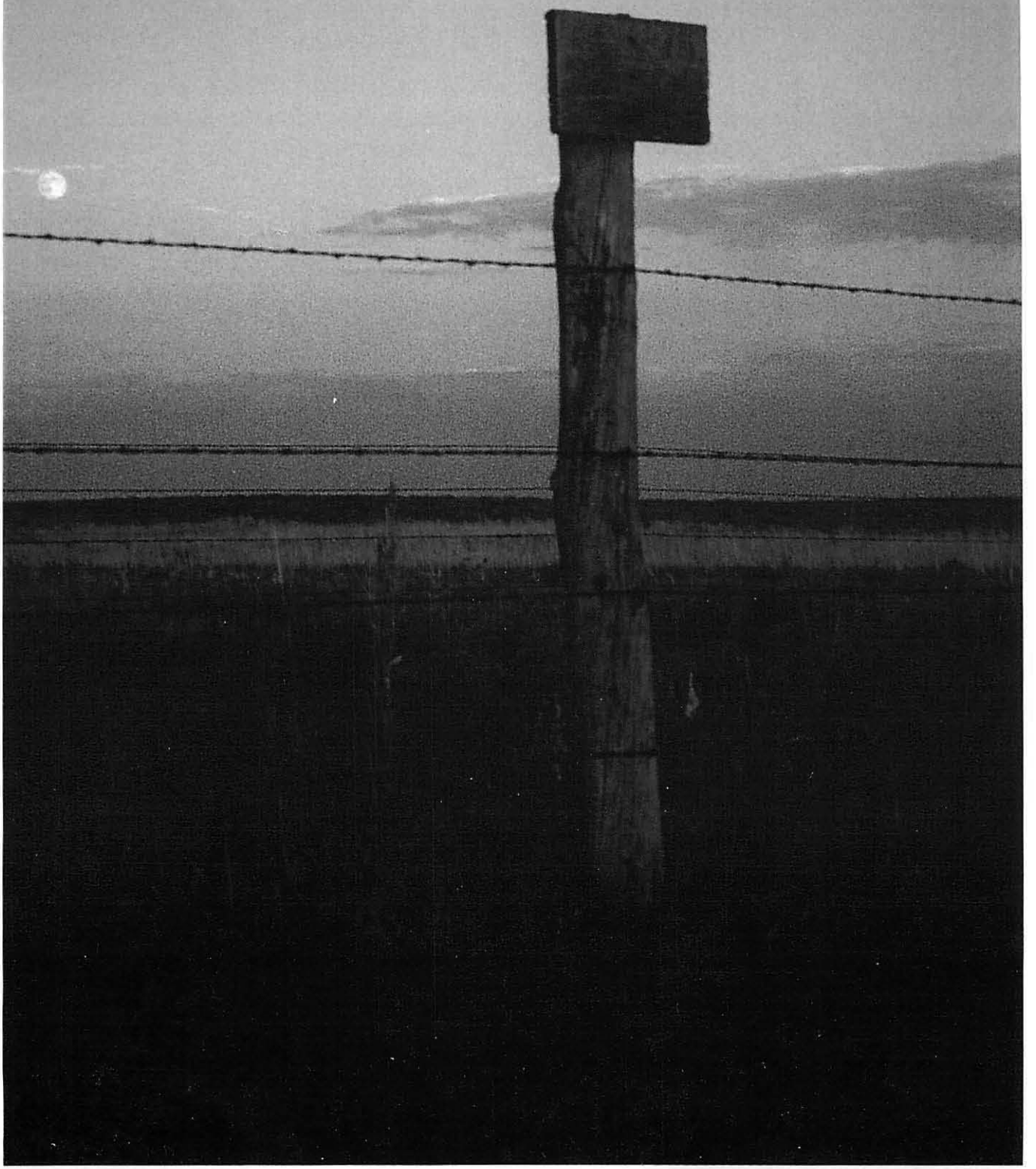
# Central Plains Experimental Range
# Third Annual Symposium

**January 11, 1996**

Sponsored by: USDA-Agricultural Research Service and
Colorado State University Long-Term Ecological Research Project



# CPER Symposium

# Agenda

# January 11, 1996

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| 7:30 | Arrival and Poster Mounting (Coffee and Rolls) |
| 8:30 | Keynote Address: "Our Future at CPER--the Perspective from a Fence Jumper" |
| | Dennis Child, Chair, Department of Rangeland Ecosystem Science, Colorado State University |
| 9:15 | Break and Posters |
| 11:00 | Poster Discussion |
| 12:00 | Lunch and CPER Trivia |
| 1:00 | Posters |
| 3:00 | Break |
| 3:15 | Poster Discussion |
| 4:15 | Adjourn |

## CPER Symposium

## Participants

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|---|---|
| Rich Alward | CSU-Biology Department |
| Mary Ashby | USDA-ARS Rangeland Resources Research<br>Central Plains Experimental Range |
| John Barret | CSU-Graduate Degree Program in Ecology |
| Meagan Bayless | CSU-Natural Resource Management |
| Andy Bean | CSU-Natural Resource Management |
| Adnan Becker | CSU-Rangeland Ecosystem Science Department |
| Brandon Bestelmeyer | CSU-Biology Department |
| Kari Bisbee | CSU-Rangeland Ecosystem Science Department |
| Indy Burke | CSU-Forest Sciences Department and<br>Natural Resource Ecology Laboratory |
| Dennis Child | CSU-Rangeland Ecosystem Science Department |
| Andres Cibils | CSU-Rangeland Ecosystem Science Department |
| Stan Clapp | USDA-ARS Rangeland Resources Research<br>Central Plains Experimental Range |
| Debra Coffin | CSU- Rangeland Ecosystem Science Department and<br>Natural Resource Ecology Laboratory |
| Martha Coleman | CSU- Forest Sciences Department |
| Lonnie Dent | UNC- Biology Department, Greeley, CO |
| Mike Dodd | CSU- Rangeland Ecosystem Science Department |

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| Howard Epstein | CSU- Graduate Degree Program in Ecology |
| Jim Eussen | UNC- Biology Department, Greeley, CO |
| Darby Finley | UNC- Biology Department, Greeley, CO |
| Jim Fitzgerald | UNC- Biology Department, Greeley, CO |
| Harold Fraleigh | CSU-Graduate Degree Program in Ecology |
| Gary Frasier | USDA-ARS Rangeland Resources Research |
| Pam Freeman | USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station<br>Cheyenne, WY |
| Rick Gill | CSU-Graduate Degree Program in Ecology |
| Larry Griffith | USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station<br>Cheyenne, WY |
| Dick Hart | USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station<br>Cheyenne, WY |
| Jack Hautaluoma | CSU- Psychology Department |
| Judy Hendryx | CSU- Rangeland Ecosystem Science Department |
| Tamara Hockstrasser | CSU- Graduate Degree Program in Ecology |
| Elisabeth Holland | National Center for Atmospheric Research<br>Boulder, CO |
| Paul Hook | MSU- Department of Animal and Range Sciences<br>Bozeman, MT |
| Bill Hunt | CSU- Rangeland Ecosystem Science Department and<br>Natural Resource Ecology Laboratory |
| Dean Kanode | Crow Valley Grazing Association |
| Robin Kelly | CSU- Natural Resource Ecology Laboratory |

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| **Bill Lauenroth** | **CSU- Rangeland Ecosystem Science Department and Natural Resource Ecology Laboratory** |
| **Dan LeCain** | **USDA-ARS Rangeland Resources Research, Crops** |
| **Jeff Losche** | **USFS- Pawnee National Grasslands** |
| **Mark Lindquist** | **CSU- Rangeland Ecosystem Science Department and Central Plains Experimental Range** |
| **Glen Liston** | **CSU- Atmospheric Science Department** |
| **Lixin Lu** | **CSU- Atmospheric Science Department** |
| **Chris Mahelona** | **USDA-ARS High Plains Grasslands High Plains Grassland Res. Station Cheyenne, WY** |
| **Jeremy Manley** | **USDA-ARS Rangeland Resources Research Central Plains Experimental Range** |
| **Maggie Marston** | **USFS- Pawnee National Grasslands** |
| **Robin Martin** | **CSU- Natural Resource Ecology Laboratory** |
| **Gustavo Martinez** | **CSU- Graduate Degree Program in Ecology** |
| **Nancy McIntyre** | **CSU- Graduate Degree Program in Ecology** |
| **Daniel Milchunas** | **CSU- Rangeland Ecosystem Science Department and Natural Resource Ecology Laboratory** |
| **Tamera Minnick** | **CSU- Graduate Degree Program in Ecology** |
| **John Moore** | **UNC- Biology Department, Greeley, CO** |
| **Jack Morgan** | **USDA-ARS Rangeland Resources Research, Crops** |
| **Matt Mortenson** | **USDA-ARS High Plains Grasslands High Plains Grassland Res. Station Cheyenne, WY** |
| **Arvin Mosier** | **USDA-ARS Soil-Plant Nutrient Research and Natural Resource Ecology Laboratory** |
| **Ken Murphy** | **CSU- Graduate Degree Program in Ecology** |

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| **Denise Noble** | **CSU- Rangeland Ecosystem Science Department** |
| **Dennis Ojima** | **CSU- Natural Resource Ecology Laboratory** |
| **Jeff Palmis** | **USDA-ARS Rangeland Resources Research<br>Central Plains Experimental Range** |
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| **Jose Paruelo** | **CSU- Rangeland Ecosystem Science Department** |
| **Bob Peterson** | **USFS- Pawnee National Grasslands** |
| **Brett Peterson** | **CSU- Fishery and Wildlife Biology Department** |
| **Roger Pielke** | **CSU- Atmospheric Science Department** |
| **Jean Reeder** | **USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station<br>Cheyenne, WY** |
| **Becky Riggle** | **CSU- Forest Sciences Department** |
| **Frank Riggle** | **USDA-NRCS-Weld County, Greeley, CO** |
| **Brian Roell** | **UNC- Biology Department, Greeley, CO** |
| **Ron Ryder** | **CSU- Fishery and Wildlife Biology Department** |
| **Maggie Schafer** | **UNC- Biology Department, Greeley, CO** |
| **Gerald Schuman** | **USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station<br>Cheyenne, WY** |
| **Paul Stapp** | **CSU- Biology Department** |
| **Elizabeth Sulzman** | **CSU- Crop and Soil Sciences** |
| **David Swift** | **CSU- Rangeland Ecosystem Science Department and<br>Natural Resource Ecology Laboratory** |
| **Ernie Taylor** | **USDA-ARS High Plains Grasslands<br>High Plains Grassland Res. Station** |

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|---|---|
| | **Cheyenne, WY** |
| **Shaharra Usnick** | **Boulder, CO** |
| **Chris Wasser** | **CSU- Rangeland Ecosystem Science Department** |
| **Ron Weeks** | **CSU- Entomology Department** |
| **Jim Welsh** | **USDA-ARS Natural Resources Research Center** |
| **Caroline Yonker** | **CSU- Crop and Soil Sciences** |

## Poster Presenters

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| **Jeb Barrett** | **Nitrogen retention in semi-arid grasslands** |
| **Kari Bisbee** | **Differential effects of increased output and decreased input due to cultivation on soil organic matter dynamics and nutrient availabiity in shortgrass steppe.** |
| **Indy Burke** | **The influence of grazing, topography, and plant species on soil redistribution and organic matter accumulation** |
| **Andres Cibils** | **A preliminary assessment of the effects of cattle-browsing on an *Atriplex canescens* population on the shortgrass steppe** |
| **Debra Coffin** | **Spatial and temporal variability in seed production of *Bouteloua gracilis*** |
| **Mike Dodd** | **Spatial and temporal analysis of growing season precipitation patterns at the CPER** |
| **Howie Epstein** | **Trace gas fluxes from C3, C4, and mixed plant communities in the shortgrass steppe** |
| **Jim Fitzgerald** | **Characteristics of dens of swift foxes in northeastern Colorado** |
| **Jim Fitzgerald** | **Population dynamics of the swift fox, *Vulpes velox*, in northern Colorado** |
| **Harold Fraleigh** | ***Bouteloua gracilis* and *Buchloe dactyloides* seed dispersal in cattle fecal pats** |
| **Gary Frasier** | **Hydrologic impact of animal, municipal, and industrial waste on rangelands** |
| **Rick Gill** | **Plant functional type influence on vertical soil organic matter dynamics** |
| **Paul Hook** | **Controls of carbon and nitrogen distribution in a shortgrass landscape: Is soil texture more important than topography?** |
| **Dan LeCain** | **Canopy $CO_2$ exchange rate of grazed and ungrazed pastures** |

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| | at the CPER |
| Glen Liston | Formulating the regional atmospheric modeling system (RAMS) for use in regional climate studies |
| Robin Martin | Seasonal controls on nitric oxide fluxes from soils of a shortgrass prairie |
| Daniel Milchunas | Livestock grazing: animal and plant biodiversity and the relationship to ecosystem function |
| Tamera Minnick | Common garden study of *Bouteloua gracilis* and Bouteloua eriopoda at the CPER in northern Colorado |
| John Moore | Integrating community structure, ecosystem processes, and system stability with the soil food web of the shortgrass steppe |
| Bill Parton | Seasonal patterns in water budget and microclimate at the CPER |
| Jose Paruelo | Interannual variability of the NDVI curves and their climatic controls in North American shrublands and grasslands |
| Brett Peterson | Small mammal populations in saltbush/grassland habitat at the CPER |
| Jean Reeder | Utilization of municipal, industrial, and animal wastes on semiarid rangelands |
| Ron Ryder | Summer trends in bird populations on the CPER and nearby areas |
| Ron Weeks | A comparison of two arthropod collection techniques |

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Barrett, J.E., and I.C. Burke. Nitrogen retention in semi-arid grasslands.

Industrial fixation of N has approximately doubled the additions of reactive forms of N to the biosphere. Anthropogenic sources of fixed N contribute to a suite of environmental problems including acid deposition, eutrophication, ground water pollution and accumulation of greenhouse gases. Additions of N in excess of plant demand may stress native terrestrial ecosystems. We are developing a series of experiments to assess the effects of elevated levels of N on native semi-arid ecosystems along a temperature and soil organic matter (SOM) gradient in the Central Grasslands of the U.S. We will use field, laboratory and simulation model analyses to address three objectives: 1.To estimate the N retention potential in soils along this gradient, 2.To identify potential sinks and loss vectors of excess N, and 3.To assess the possible effects of climate change and landuse on N dynamics. Five field sites span a temperature and SOM gradient from the northern mixed grass prairie in eastern Montana and Wyoming to the shortgrass steppe in eastern Colorado and the Panhandle of Texas. We will estimate gross immobilization as an index of N retention potentials for these sites using 5 day laboratory incubations and the $^{15}N$ pool dilution method. A field study will be used to assess the ability of native grassland systems to respond to additions of N in excess of plant demand. We will apply two levels of $^{15}N$ labeled $NH_4SO_4$ to coarse and fine textured soils at these five sites . Soils and plant tissue will be collected over the following two years to determine paths of N storage and loss. We will use a N trace gas model linked to the CENTURY SOM model to predict N retention and loss for two levels of N addition and several landuse scenarios at both current climatic conditions and climate conditions predicted by global circulation models. We will use climate and soil texture variables from the five sites in the field experiment to run the model for validation of the current conditions.

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Bisbee, Kari E., Ingrid C. Burke, and Robin H. Kelly. Differential effects of increased output and decreased input due to cultivation on soil organic matter dynamics and nutrient availability in shortgrass steppe.

Cultivation decreases soil organic matter (SOM) due to fewer plant residue inputs and greater outputs such as decomposition and erosion, but the relative effects of these processes are unknown. We designed a study to separate the effects of alteration of inputs and outputs on total and active SOM pools. We sampled four different SOM manipulations: high litter inputs (beneath live plants); low litter inputs (interspace); lack of litter inputs (ant-induced bare area); and high-erosion, high-decomposition, low litter inputs (wheat-fallow agriculture)at two sites in and near the Pawnee National Grasslands. A cultivated system and a native system with 90% of all plant removal were simulated using the Century Ecosystem Model. Both active and total pools decreased in response to decreasing litter inputs, and the highest losses were found in cultivated treatments. Our study suggests that 1) depending on topographic position, erosion may both increase SOM inputs to and increase SOM outputs from a cultivated system, 2) plant absence in native areas confers comparable variability to landuse management practices, and 3) when comparing Century simulations to our field data, we found that Century overestimates the amount of loss in SOM due to increased erosion and decomposition and underestimates the amount of SOM loss due to reduced plant litter inputs.

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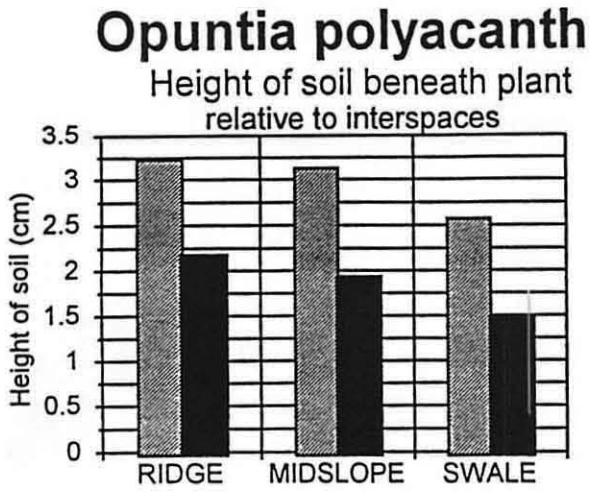
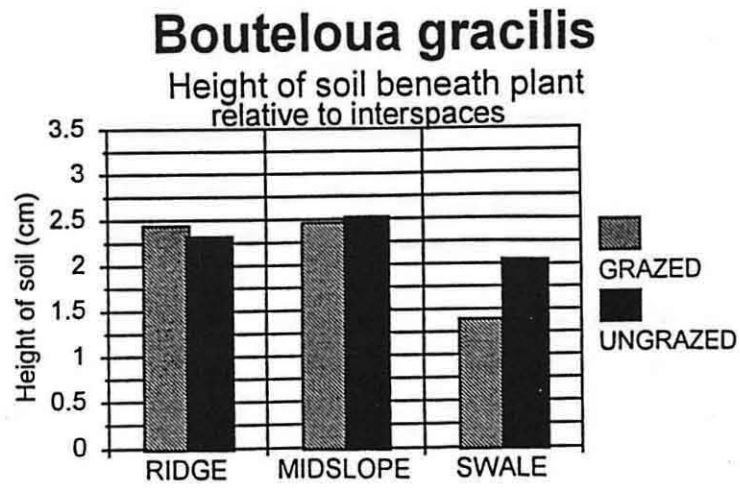
Burke, I. C., W. K. Lauenroth, P. Brannen, B. Madigan, and B. Riggle. Colorado State University. The influence of grazing, topography, and plant species on soil redistribution and organic matter accumulation.

A large number of experiments have demonstrated that organic matter in semiarid ecosystems tends to be concentrated under perenial plants relative to the interspaces between plants. Our previous work has shown that there is very strong plant-induced heterogeneity associated with many of the bunchgrasses in the shortgrass steppe. Our explanation for this pattern invokes two mechanisms, concentrated productivity under plants relative to between, and the redistribution of soil mineral and organic matter from interspaces to under plants.

We have initiated a study to investigate the mechanisms and controls over plant-induced soil heterogeneity. We sampled grazed and ungrazed pastures, on ridgetops, midslopes, and swales. In each combination of treatments, we measured microtopographic relief by estimating the height of soils under *Bouteloua gracilis* and *Opuntia polyacantha* relative to interspaces between plants. We then sampled soils under these plants to a depth that matches the interspace soil height. We are characterizing the accumulated material for soil texture, particulate organic matter, mineralizable C and N, and total C, N, and P .

To date, we have results from the microtopography analysis. Our results indicate that there is significant microtopograhic relief in all locations and under both species. Ridges and midslopes experienced more soil redistribution (higher microtopgraphic relief) than swales. Our data show interesting interactions between plant species and grazing. Grazing influenced microtopographic relief under *O. polyacantha* but not *B. gracilis*, with significantly greater relief in heavily grazed pastures than ungrazed for all topographic positions. There are two possible mechanisms that may explain these patterns. First, grazing enhances physical soil redistribution, but the soil accumulates under *O. polyacantha* and not *B. gracilis* because the cactus is not grazed or trampled, leading to depositional zones under these plants (physical soil redistribution mechanism). Second, the lack of consumption of *O. polyacantha* under grazing leads to higher accumulations of organic matter under these plants, which does not occur with *B. gracilis* because it is consumed by cattle (heterogeneity of production mechanism). We may be able to distinguish between these two mechanisms through our characterization of the material under plants relative to interspaces.



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Cibils, Andrés and Adnan Beker . A preliminary assessment of the effects of cattle-browsing on an *Atriplex canescens* population on the Short Grass Steppe.


*Atriplex canescens* is a dioecious, wind-pollinated, fairly short-lived shrub. On the plains, *Atriplex* stands can be found on the coarser textured soils of drainage overflow sites. Due to the fact that they are evergreens and exhibit remarkably high contents of crude protein, *Atriplex canescens* stands are considered to be a valuable winter forage resource for livestock and wildlife. We carried out a preliminary assessment of stem and crown morphology, shrub density and sex ratios in a long-term winter-grazed pasture, a long-term summer-grazed pasture, and two protected areas of approximately 25 and 50 years of cattle exclusion. Study sites were all located close to the Owl Creek at the Central Plains Experimental Range. The main objective of our study was to gain greater insight on the dynamics of this local population of *Atriplex canescens*. Our data suggest that browsing by cattle may affect sexual phenotypes of *Atriplex canescens* differently. Exclusion from grazing, on the other hand, could affect the recruitment of new individuals. Winter-browsed shrub stands appear to exhibit symptoms of greater stress relative to either summer-browsed stands or exclosures.

1996 CPER Symposium


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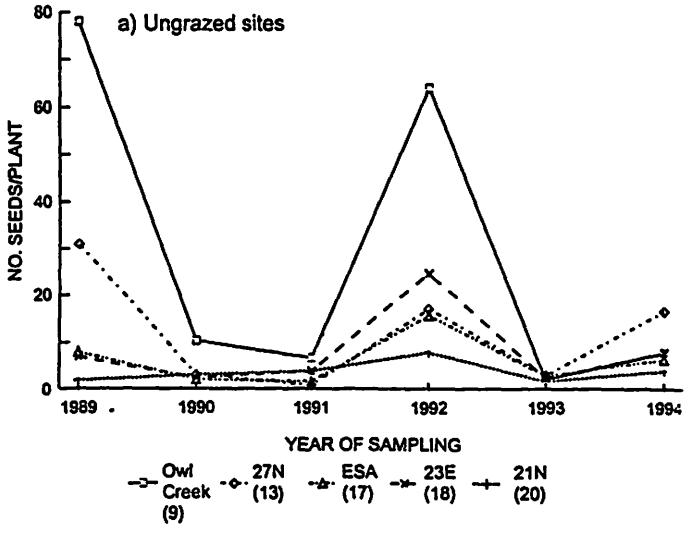
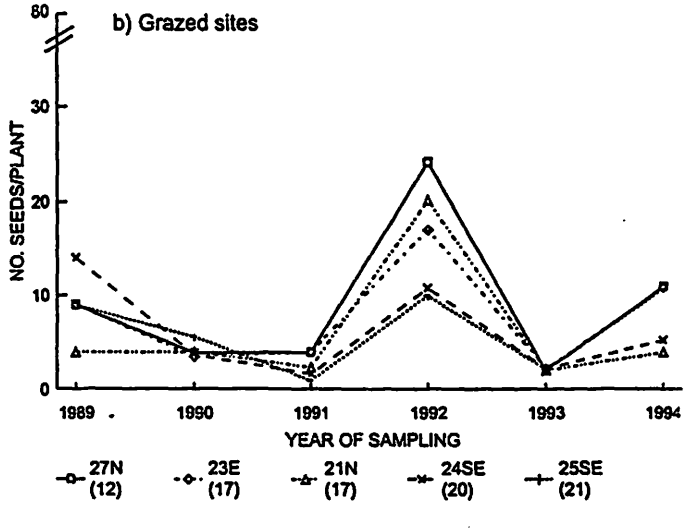
Coffin, Debra P., and William K. Lauenroth. Spatial and temporal variability in seed production of *Bouteloua gracilis*


We evaluated the spatial and temporal variability in seed production of *Bouteloua gracilis* (blue grama) by sampling ten sites varying in soil texture and grazing intensity at the CPER from 1989-1994. Locations included a coarse-textured loamy sand soil and a fine-textured sandy clay loam. The remaining eight locations were sandy loam soils that differed in their percentage clay and sand contents. Six of the ten locations consisted of three pairs of adjacent ungrazed-grazed locations with similar soil textures and topographic positions. Sampling was conducted in September or October of each year to correspond to the time between seed maturation and dispersal. A total of 96 *B. gracilis* plants were sampled at each site in each year. Number of flowering culms, inflorescences and seeds, length of each flowering culm, and total biomass of reproductive structures were assessed for each plant.

Large between-site variability in seed production was observed that was more pronounced for ungrazed compared to grazed sites. Production of *B. gracilis* seeds decreased with increasing clay content of the soil. Large inter-annual variability in seed production was found with largest amounts of seed produced in 1989 and 1992 for ungrazed sites, and in 1992 for grazed sites. In most years, ungrazed sites with low clay content (<15%) had higher seed production than grazed sites with comparable soil texture. These results showing large between-site and inter-annual variability in seed production of *B. gracilis* indicate that availability of seeds may be an important constraint on the ability of this species to recover after disturbances that also vary in space and time.

Abstract for 1996 CPER Symposium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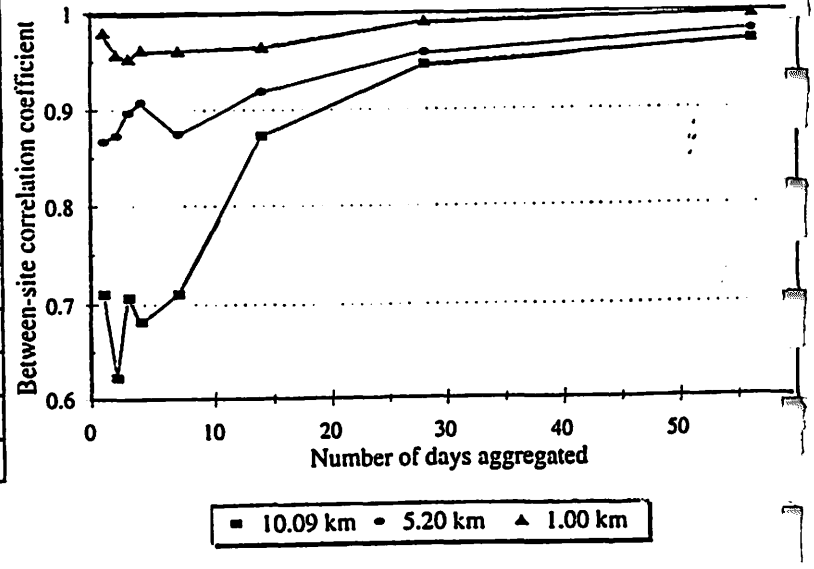
Dodd, Michael B. and William K. Lauenroth. Spatial and temporal analysis of growing season precipitation patterns at the CPER.


We collated historical precipitation data from several sites at the CPER into two databases for the spatial and temporal analysis of between-site correlation coefficients. The first data set included daily precipitation measurements from 5 sites during the growing seasons (April-September) of the years 1988-1994; the second included daily precipitation measurements from 11 sites during the growing seasons of 1994-1995. We performed a simple linear regression analysis of the correlation coefficients (R) between all site pairs vs their distances apart. This showed a negative linear relationship, which was significant for the 11-site analysis only (Table 1). Daily precipitation data was aggregated to 2, 3, 7, 14, 28, and 56 days and a similar analysis performed. The value of R increased in an exponential fashion (approaching 1.0) with greater temporal aggregation, the increase being greater for sites that were further apart (Fig. 1). The relationship between R and distance remained a negative linear one for all aggregations. In general, both the $R^2$ and slope of the relationship decreased, with greater temporal aggregation of data (Table 1). The exception to this pattern was the 56-day analysis, the model for which was not significant.


Table 1: Linear model parameters for between-site correlation coefficient vs distance

| Time period | $R^2$ | | Slope of linear model | |
|---|---|---|---|---|
| | 5 sites | 11 sites | 5 sites | 11 sites |
| 1 day | 0.016 | 0.621 | -0.007 | -0.029 |
| 2 days | 0.702 | 0.586 | -0.023 | -0.038 |
| 3 days | 0.818 | 0.548 | -0.023 | -0.031 |
| 4 days | 0.681 | 0.584 | -0.020 | -0.033 |
| 7 days | 0.603 | 0.573 | -0.017 | -0.029 |
| 14 days | 0.647 | 0.167 | -0.016 | -0.006 |
| 28 days | 0.360 | 0.338 | -0.012 | -0.004 |
| 56 days | 0.345 | 0.014 | -0.009 | -0.001 |
| season | 0.129 | - | -0.014 | - |

**Fig 1. Precipitation correlation**
R vs aggregation for 3 site pairs



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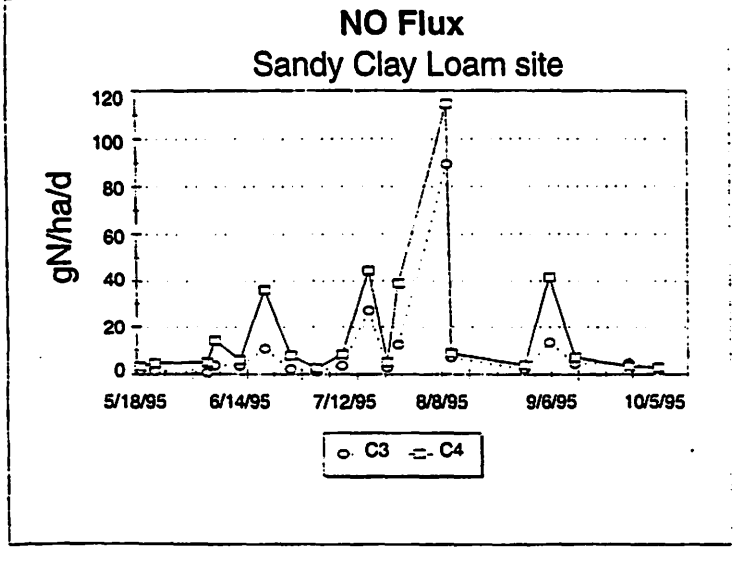
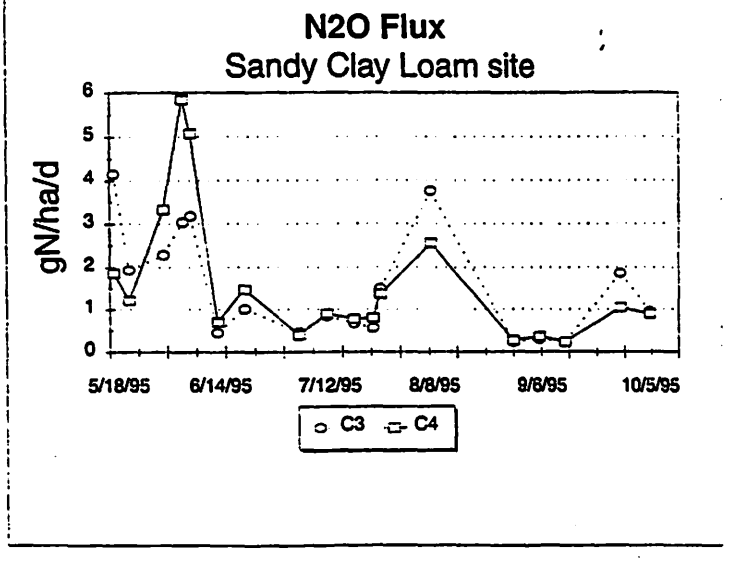
Epstein, H.E., Burke, I.C., Mosier, A.R. and G.L. Hutchinson. Trace gas fluxes from $C_3$, $C_4$ and mixed plant communities in the shortgrass steppe.

We conducted a study to examine the influence of plant species with different growing seasons on the intraseasonal patterns of trace gas fluxes. We collected trace gas samples of $N_2O$, NO, $CH_4$ and $CO_2$ for twenty sampling dates throughout the growing season. Samples were collected from two sites, a sandy clay loam and a clay. At each site, we analyzed plots of $C_3$ grasses, $C_4$ grasses or a mixture of the two types. $N_2O$ fluxes were generally highest (>5gN/ha/d) during the very wet spring and lowest during the dry summer (<1gN/ha/d). NO fluxes were highest following precipitation or wetting events (max. of >100gN/ha/d), yet remained relatively low during the abnormally wet spring. $CH_4$ uptake was highest during the dry summer (~4gC/ha/d) and lowest during wet periods. $CO_2$ flux peaked during the late spring (~60kgC/ha/d) and declined throughout the remainder of the growing season, with the exception of wetting events. NO and $CO_2$ fluxes, and $CH_4$ uptake, were generally higher at the coarser-textured site. There were no clear differences in $N_2O$ fluxes between sites. $C_4$ communities had higher NO fluxes than $C_3$ communities for most of the sampling dates at both sites. $CH_4$ uptake was higher in the $C_4$ plots for most of the sampling dates at the coarser-textured site, but not at the clay site. $N_2O$ fluxes were higher in $C_4$ plots for several consecutive sampling dates at both sites during the wet spring. $CO_2$ fluxes were higher for $C_3$ plots through early summer, following which differences appear minimal. We are currently performing statistical analyses on these results.



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Fitzgerald, J. P., L. Dent, M. Schafer, and B. Roell
Characteristics of dens of swift foxes in northeastern Colorado

Den site characteristics were determined for 61 dens used by swift foxes in 94-95 as either pup rearing dens (15) or diurnal dens. The mean width of den openings was 20.6 cm (range 12-31, SD = 3.5). Mean height was 18.6 (range 11-33, SD = 3.7). Dens were located on slopes averaging 2.4 degrees (range 0-12 degrees, SD = 2.2). Den sites averaged 56 percent cover of perennial grasses, with a mean height of vegetation of 12.6 cm. Dens had from 1-3 entrances (mean = 1.4). Den spacing was clustered, 29 dens on the CPER in sections for which detailed vegetation maps existed had primary vegetation of blue grama and secondary vegetation of either buffalo-grass (24 dens), opuntia (3 dens), rabbitbrush (1), or tumbleweed (1). No active dens were located in saltbush or yucca communities. Line transect counts found a significantly ($X^2$ = 21.3, 1 d.f., $P < .01$) higher number of dens in historically heavily grazed pasture (Section 23, east) than in lightly grazed (Section 23, west) pasture. Whelping dens did not differ significantly in their characteristics from other dens. evaluated.

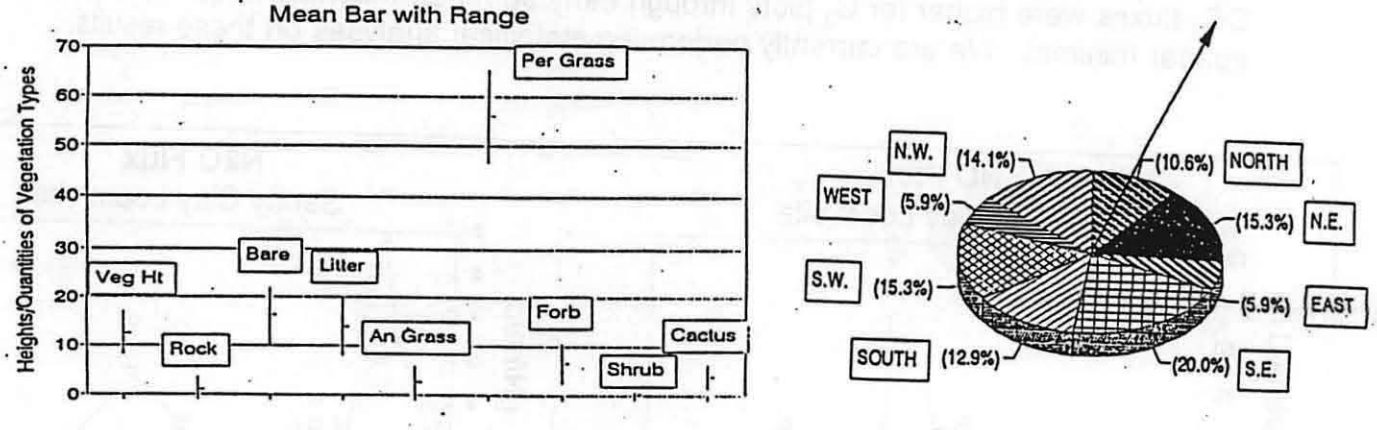


Figure 1. Mean heights, percent cover, and aspect of openings of swift fox dens, northeastern Colorado.

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Fitzgerald, J., B. Roell, L. Dent, M. Schafer, L.Irby, J. Eussen and D. Finley

Population dynamics of the swift fox, Vulpes velox, in northern Colorado.

Since mid-October 1994, 75 swift foxes have been captured and radio-collared. Nineteen foxes (10 adult males, 9 adult females) were captured on a 20 square mile (51.8km$^2$) area on the Pawnee National Grassland (G1 site). The other 56 foxes have been trapped on a 96km$^2$ site centered on the Central Plains Experimental Range. CPER captures include 22 adult males, 6 male pups, 17 adult females, and 11 female pups. Eighteen (25%) foxes have been found dead with 67% of the deaths from coyotes. From a cohort group of 31 foxes (14 female, 17 male) captured on the CPER between October and mid-December 1994, 2 females (14%) are alive, 6 (43%) are dead, and the fate of 6 is unknown. Five of the males (29%) are alive, 7 (42%) are dead, and the fate of 5 is unknown. Foxes using CPER lands in the SE quadrant of the site or south of road 114 have had the higher mortality. Six dead males (86%), and 3 females (50%) were killed in this area. Differential mortality was attributed to an increase in agricultural lands, and more broken topography resulting in higher coyote predation. It is assumed that most of the animals we are unable to locate have either immigrated or are dead. Home ranges for 2 adult males and 2 adult females on the CPER average 4.8miles$^2$ (12.6km$^2$). A cohort group of 19 foxes (10 male, 9 female) radio-collared in March on G1 had lower mortality (21%), and fewer animals of unknown status (26%). The G1 site has less broken relief and coyote densities are believed to be lower than on the CPER. Reproductive success on both sites was low in 1995. Of 15 adult females 9 (60%) produced litters that emerged from below ground. Litter size averaged 1.7 animals. The cold, wet spring is believed to have effected pup survival by reducing hunting success of adults provisioning young.

Table 1. Number, sex, age, and % alive ( ), of swift foxes captured on the CPER and G1 sites, northern Weld County, Colorado, October 1994 - December 95.

| Site | 1994 Captures Sex and Age | | | | 1995 Captures Sex and Age | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Males | | Females | | Total |
| CPER | Adult | Pup | Adult | Pup | Adult | Pup | Adult | Pup | |
| | 15(29) | 2(0) | 9(22) | 5(0) | 7(57) | 4(50) | 8(50) | 6(83) | 56(39) |
| G1 | -- | -- | -- | -- | 10(50) | | 9(67) | | 19(58) |

## SUMMARY FORM: 1996 CPER SYMPOSIUM


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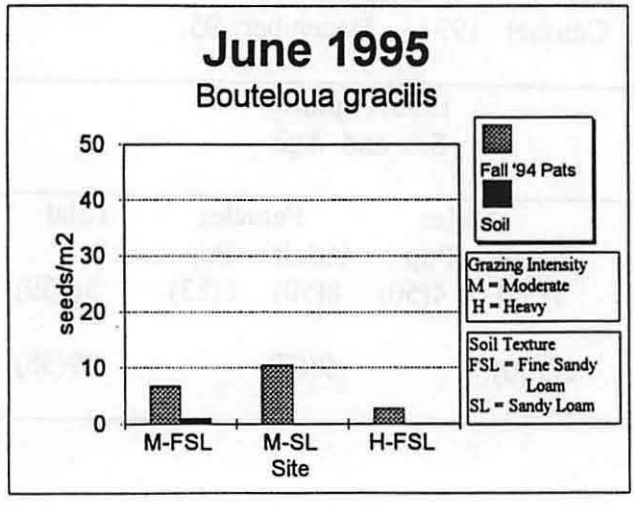
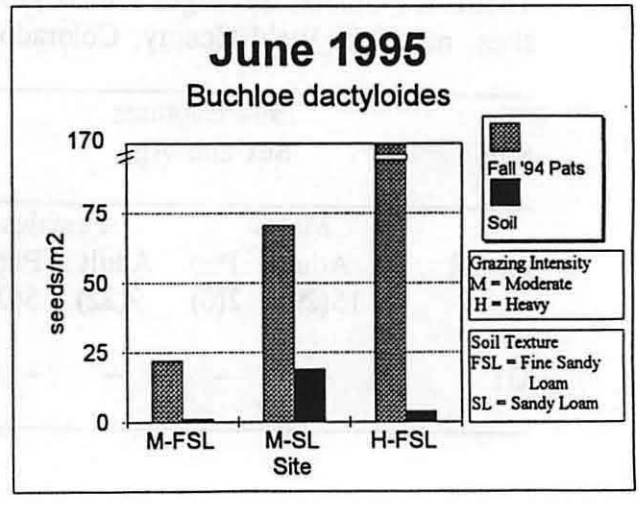
Fraleigh, Harold D., and Debra P. Coffin. *Bouteloua gracilis* and *Buchloe dactyloides* seed dispersal in cattle fecal pats.


Wind is generally thought to be the most important vector of seed dispersal for most grasses. The rate of *Bouteloua gracilis* (blue grama) and *Buchloe dactyloides* (buffalo grass) reestablishment throughout abandoned agricultural fields in the shortgrass steppe cannot be explained by the current understanding of wind-borne dispersal alone. Clonal spread also cannot explain all revegetation patterns. Seed dispersal by large herbivores may play an important role in the revegetation dynamics of large disturbances, including the reestablishment of dominants in the plant community. We collected cattle fecal pats of known ages at the CPER and evaluated viable seed availability within the pats by germination in the greenhouse. We also collected soil samples from the same fields at the pat collection times. We compared seed availability in the soil seedbank to that of the fecal pats. This study demonstrates that *B. gracilis* and *B. dactyloides* seeds are eaten, distributed in cattle fecal pats, and viable the following spring when seeds are germinating. The fecal pats may contain a higher concentration of viable seeds than the surrounding soils in *B. gracilis*/*B. dactyloides* dominated fields. The results of this study indicate that redistribution of seeds through fecal pat deposition is an important source of dispersal of *B. gracilis* and *B. dactyloides* seeds on large disturbances, and likely contribute to their recovery on these areas.

**SUMMARY FORM: 1996 CPER SYMPOSIUM**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Frasier, Gary W., Gerald Schuman, Jean Reeder, Pam Lyman, and Dennis Mueller. Hydrologic Impact of Animal, Municipal and Industrial Waste on Rangelands.


A study was conducted to evaluate the hydrologic effects of applying animal, municipal, and industrial wastes on native shortgrass rangeland at the Central Plains Experimental Range. The waste materials used in the studies were (1) fresh animal waste, (2) composted animal waste, (3) dried sewage sludge, (4) phosphogypsum (an industrial waste product) and (5) control (no treatment). The waste materials were applied at a rate of 10 tons per acre to individual 10 x 30 ft. plots. The rotating boom rainfall simulator was used to measure the runoff water quantity. One half of the plots were evaluated within 3 days of application in May 1993. All the plots were evaluated in August 1993 and the May 1993 plots re-evaluated in August 1995. At the time of application (May 1993), the equilibrium runoff from the fresh animal waste and the composted animal waste were less than from the control. The runoff from the other treatments were not different than the control. In August the runoff from the fresh animal waste (40%) and dried sewage sludge (54%) was less than the control (60%) but the phosphogypsum was greater (80%). By August of 1995 runoff from the control had dropped to 44% but all the treatements had decreased significantly more. These results show that the treatments can improve infiltration but that it may take several years for the benefits to be realized.


Equilibrium runoff rates from a 45 minute rainfall simulator run.

| | | Treatment | | | |
|---|---|---|---|---|---|
| Evaluation Period | Phosphogypsum | Fresh Animal Waste | Composted Animal Waste | Dried Sewage Sludge | Control |
| | (%) | (%) | (%) | (%) | (%) |
| May 1993 | 64 | 40 | 46 | 56 | 59 |
| August 1993 | 80 | 40 | 62 | 54 | 60 |
| August 1995 | 38 | 12 | 13 | 19 | 44 |

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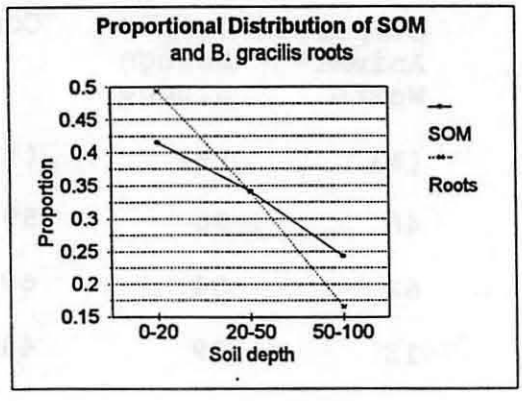
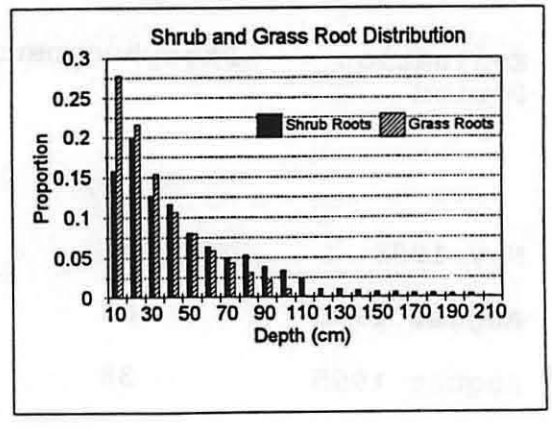
Gill, Richard A., Ingrid C. Burke, William K. Lauenroth, and Daniel G. Milchunas. Plant Functional Type Influence on Vertical Soil Organic Matter Dynamics

Several studies show the importance of plant presence on horizontal soil organic matter (SOM) distribution in grasslands and shrublands. However, plant control of vertical SOM distribution is poorly understood. We are beginning several studies to assess the influence of plant functional type composition on vertical SOM dynamics and carbon storage in semiarid grasslands. We hypothesize that a complex relationship between root input and decomposition with depth control the distribution of soil C because of variation in temperature, water availability, and oxygen concentration through the soil profile. We will test this hypothesis by conducting field work in semiarid grasslands of Colorado and New Mexico. Our first objective is to characterize vertical SOM distribution in systems where shrubs or grasses have dominated for the period of available record. We intend to characterize physical and chemical fractions that correspond to theoretically-based kinetic SOM pools. Second, we propose to measure vertical variation in root input and decomposition through the soil profile. We will measure root turnover using a minirhizotron at grass and shrub sites at the CPER. Decomposition will be measured using buried litterbags containing either *Bouteloua gracilis* or *Atriplex canescens* roots. In summer 1995 we sampled a CPER site where plants were pulse-labeled with $^{14}C$ in 1985. We are currently analyzing these samples to determine root density, mineralizable C, particulate organic matter C, total C, and $^{14}C$ concentration in each of these pools with depth. These data will characterize 10 years of root input into SOM fractions. Finally, we will use stable isotope techniques to evaluate the influence of shrub invasion on grassland organic matter dynamics. These studies will address the influence that plants with different rooting patterns have on organic matter dynamics in semiarid grasslands.



## SUMMARY FORM: 1996 CPER SYMPOSIUM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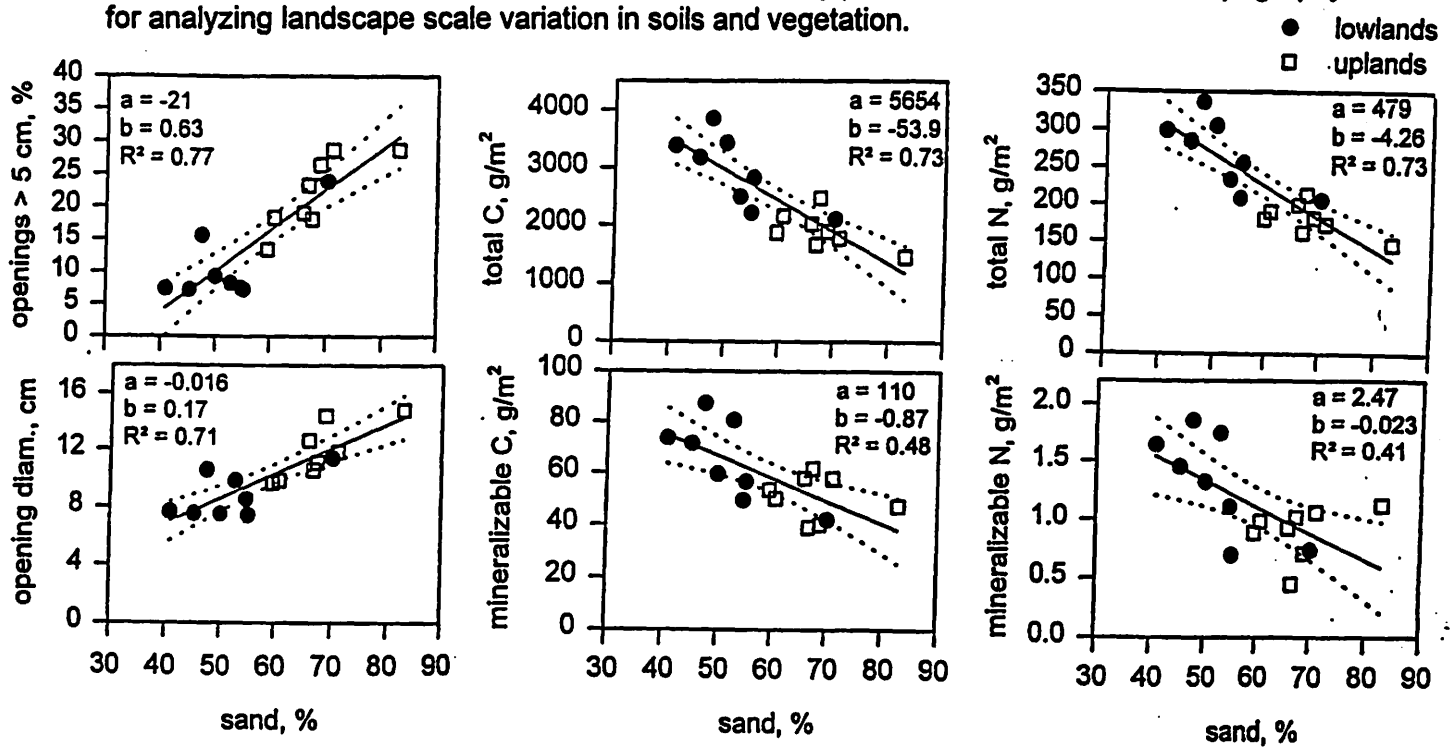
Hook, Paul B., and Ingrid C. Burke. Controls of carbon and nitrogen distribution in a shortgrass landscape: Is soil texture more important than topography?


One of the prevailing concepts used to explain soil patterns in grasslands is the catena hypothesis, which argues that hillslope hydrologic and geomorphic processes produce consistent topographic patterns of soil development, biogeochemistry, and plant ecology. Most support for the catena hypothesis is from studies involving few, subjectively selected hillslopes, and consistency across landscapes has not been established. Statistical analyses have shown that soil texture is an important factor controlling regional distribution of soil carbon and nutrients, but the importance of texture at landscape scales is not known. We used a hierarchical sampling scheme to evaluate patterns of C and N distribution at decimeter to kilometer scales in a shortgrass landscape. Surface soil was sampled under plants and in bare interspaces in 8 pairs of upland and lowland sites. Sample sites were dispersed across the Central Plains Experimental Range in diverse physiographic settings, in watersheds ranging from 1 to 6600 ha. Results showed that lowland sites generally have higher C, N, and clay content, higher plant cover, and fewer and smaller interspaces. Variability within topographic positions was large, however, and characteristics of uplands and lowlands overlapped. Topographic differences varied significantly among sites, ranging from strong to absent. Soil texture explained much of the variation among sites and between topographic positions. Sand content was related to interspace area, mean size of openings, and total and mineralizable C and N (see figure), as well as plant cover and C and N in particulate organic matter. Based on these results and other studies, we suggest that soil texture acts as a "master variable" that influences soil organic matter, nutrients, and vegetation structure. Low frequency of runoff and aeolian redistribution of surficial materials may limit topographic differentiation of soils in shortgrass steppe. Consequently, textural variation may provide a better basis than topography for analyzing landscape scale variation in soils and vegetation.

1996 CPER SYMPOSIUM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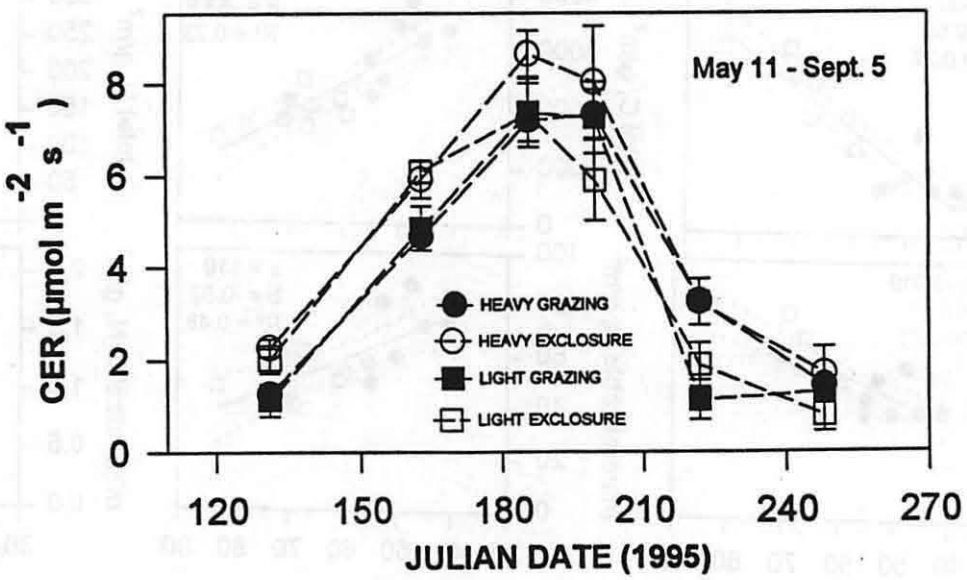
LeCain, D.R., J.A. Morgan, G.E. Schuman, R.H. Hart and J.D. Reeder. Canopy $CO_2$ Exchange Rate of Grazed and Ungrazed Pastures at the CPER.

In order to better understand the influence of grazing on carbon cycling of the Colorado short grass steppe, we measured canopy $CO_2$ exchange rate (CER) of Heavily Grazed (.23 steers/ha) and Lightly Grazed (.12 steers/ha) pastures and their neighboring exclosures at the CPER. A clear-sided, closed-system CER chamber which enclosed one $m^2$ of ground was used on five plots in each of the four pastures. CER measurements were taken six times from May 11, 1995 to Sept. 5 1995 along with leaf area index (LAI), species composition, soil moisture and ambient air temperature. Data from the first year of measurements suggests a higher rate of canopy CER in the exclosures during the early portion of the growing season (May and June) which diminishes as the season progresses (July, August and September). Treatment differences in CER did not correlate well with total LAI, but instead were associated with the seasonal changes in the proportion of $C_3$ and $C_4$ species in these pastures. The exclosures had a greater amount of $C_3$ species contributing to total LAI (primarily *Stipa comata, Artemesia frigida, Gutierrezia sarothrae* and *Carex spp.*) , especially early in the growing season. Higher CER in the exclosures seem to relate to the cooler temperature optima for $C_3$ photosynthesis (spring 1995 was uncharacteristically cool) . Grazed pastures had a greater percentage of $C_4$ species (primarily *Bouteloua gracilis* and *Aristida longiseta)* which have higher temperature optima for photosynthesis. As the season progressed, warmer temperatures and declining soil moisture decreased the percentage of active $C_3$ species in the exclosures, whereas the $C_3$:$C_4$ ratio in the grazed pastures remained fairly constant. Earlier senescence in the exclosures along with temperatures more favorable to the grazed plots eliminated the CER differences between treatments in July, August and September. We are planning at least two more years of data collection on this study.



# Formulating the Regional Atmospheric Modeling System (RAMS) for Use in Regional Climate Studies

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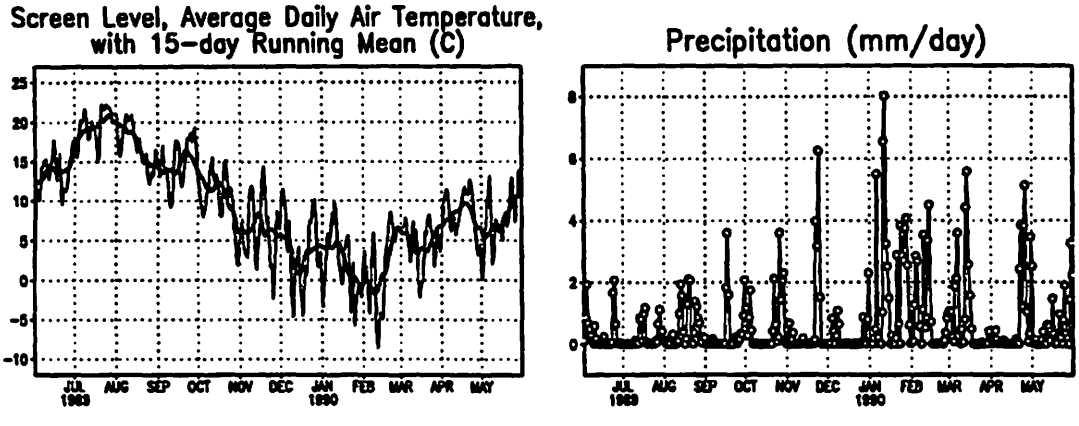
A climate version of the Colorado State University, Regional Atmospheric Modeling System (RAMS) has been developed which is capable of efficiently performing full annual integrations. To meet the requirements of a regional climate model, several modifications to the existing modeling system had to be made, including: the seasonal evolution of sea surface temperatures, vegetation parameters, and the deep soil temperatures were automated and are now updated daily; a collection of routines which adequately simulates snow accumulation, snow melt, and their effects on surface hydrology and surface energy exchanges were implemented; radiation and moisture physics routines of the appropriate complexity for long model runs were implemented; sufficient variables are now saved to perform complete surface energy and moisture balances; efficient data storage and handling routines and procedures were implemented; depending on the model output variable, data is saved on an hourly, six-hourly, or daily basis. In addition to model development and performing the annual runs, a model validation program has been implemented to assist in comparing the model output and the observations. The observational data sets appropriate for model validation at hourly to seasonal time scales have been collected for the United States region covering the period 1987 through 1994, and appropriate procedures for making the comparisons are being developed. The current period of focus in our model runs has been June 1989 through May 1990 (see attached figure). The model spatial domain covers the United States using a 180 km grid, and includes a more focused study region, using a 60 km grid, which is centered over Wyoming, South Dakota, Nebraska, Kansas, and Colorado. These annual model integrations will be used to assist in evaluating the importance of land surface properties on governing weather and climate, and the influence of the weather and climate on the evolution of the land surface. To accomplish this we will be integrating various components of the CENTURY regional ecosystem model and the MAPSS biome distribution model into our RAMS climate modeling efforts.

## Example RAMS Daily Grid-Cell Output



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R.E. Martin, M.E. Scholes, A.R. Mosier, D.S. Ojima, W.J. Parton, and E. Holland.

SEASONAL CONTROLS ON NITRIC OXIDE FLUXES FROM SOILS OF A SHORTGRASS PRAIRIE

Fluxes of nitric oxide (NO) were measured from the soils of the shortgrass prairie at the Central Plains Experimental Range, Nunn, Colorado. Seasonal data were collected and manipulative experiments were performed on 5 sites with differing textures, landscape positions, and land uses. These sites were chosen to give a range of water filled pore spaces (WFPS) and nutrient availabilities. Over the season the NO flux was controlled by temperature and WFPS. The highest fluxes (25-200 $\mu gNO/m^2/hr$), found in mid-summer were 40 times greater than the nitrous oxide fluxes. The lowest fluxes (6-10 $\mu gNO/m^2/hr$) were during the winter. In the summer low WFPS was the limiting factor; in the winter temperature was limiting. Wetting to stimulate light and heavy rainfalls produce quick and large (100-300 $\mu gNO/m^2/hr$) responses. NO flux peaked between 30 minutes and 4 hours. The initial response appears to be related to substrate availability. The duration of the response is more closely controlled by WFPS.

Nitric oxide (NO) emissions from soils are important both as a key loss of nitrogen in nitrogen cycling within the soil and to the cycling of nitrogen through the atmosphere. NO also referred to as $NO_x$ indicating NO + $NO_2$ controls the oxidative capacity of the troposphere (Shepherd, 1991). At high concentrations $NO_2$ contributes to the production of ozone and the OH radical, while at low concentrations NO will destroy ozone (Williams, 1992 a).

Although soils are believed to be a major source of NO globally, the magnitude of the soil source is not well known (Logan, 1983; Williams et al, 1992 a). One of the main problems for global estimations is the lack of year round data (Williams et al, 1992 b). The factors controlling the production and consumption of NO in soils are also poorly understood (Firestone, 1989). NO is produced during nitrification, denitrification and through the chemical decomposition of $HNO_2$ but, the relative contributions of each are unclear (Firestone, 1989).

Our focus was to collect a long term seasonal data set from a temperate grassland and through short term manipulative experiments try to distinguish some of the controls on the NO production from the soil.

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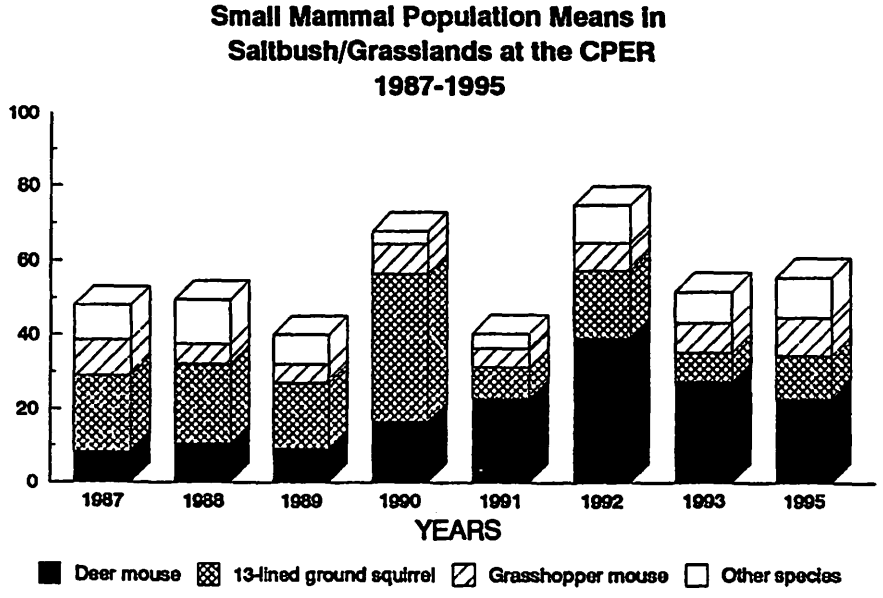
McEwen, Lowell C., and Christine M. Althouse. SMALL MAMMAL POPULATIONS IN SALTBUSH/GRASSLAND HABITAT AT THE CPER.

Three saltbush (Atriplex) plots (5.0ha each) at the CPER have been live-trapped for small mammal population studies since 1987. Two of these plots were sprayed in 1988 with methamidophos for an investigation of insecticide effects on nontarget animal life. Beginning in 1989 the primary study objective was changed to determine long term fluctuations in species composition and abundance of the small mammal community. Of 10 species captured on the plots, 3 species have consistently been the most abundant: deer mice, grasshopper mice, and 13-lined ground squirrels. Seven species have remained at low densities, averaging <1 individual of each species/ha, although prairie voles showed a small increase in 1995 when precipitation and plant growth were above average. Grasshopper mouse numbers remained relatively stable on all 3 plots, averaging 1 to 2/ha throughout. The greatest changes were found in 13-lined ground squirrel and deer mouse populations. The ground squirrels were the most numerous species on all plots ( $\bar{x}$ = 5.1/ha) for 4 years, 1987-1990, then declined sharply ( $\bar{x}$ = 1.2/ha) during 1991-1995. Deer mouse numbers increased greatly from a mean of 2.3/ha in 1987-1990 to 5.9/ha in 1991-1995 apparently in response to the ground squirrel decline. We also have additional data on small mammals from other plots at the CPER that were not trapped as regularly. The large data set we have acquired (37,897 trap nights; 2,552 captures) could profitably be examined for possible relationships to annual precipitation patterns, vegetation standing crop, and seed production at the CPER during the period 1987-1995.



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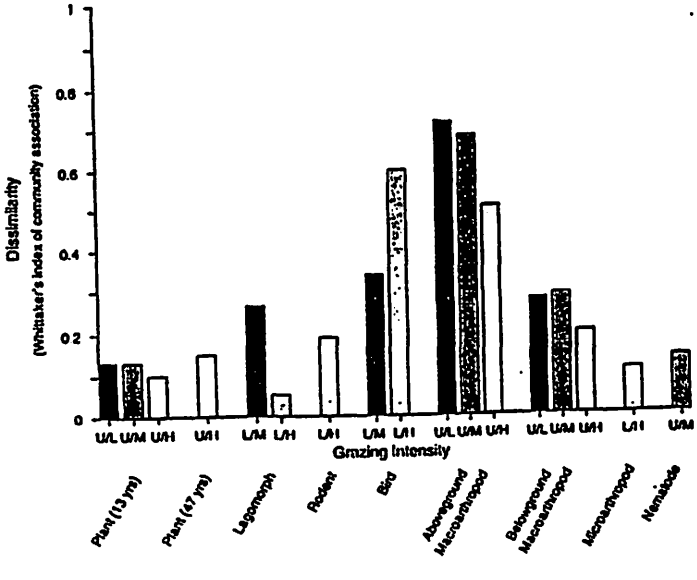
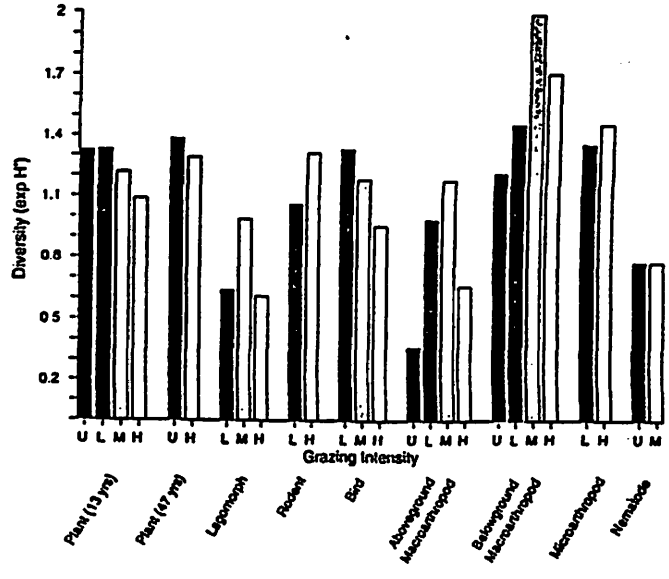
Milchunas, D. G., W. K. Lauenroth, and I. C. Burke. **Livestock Grazing: Animal and Plant Biodiversity and the Relationship to Ecosystem Function**

We synthesized published and unpublished data from long-term grazing treatments in the shortgrass steppe on the diversity and abundance of plants, lagomorphs, rodents, birds, aboveground and belowground macroarthropods, microarthropods, and nematodes. The relatively invariant nature of the shortgrass steppe plant community in response to grazing provides an opportunity to address some broad questions concerning relationships between responses of various structural and functional aspects of systems in general. Are there consistencies in diversity and abundance responses to grazing between groups of organisms? Are some groups more sensitive than others, or do responses mirror that of vegetation? Are the responses in terms of biodiversity related to functional responses?

Responses to long-term grazing intensity treatments in term of diversity, abundance, dominance, and dissimilarity were highly variable across classes of organisms. Some groups of consumers displayed large differences between grazing treatments even though differences in plant community attributes were relatively minor. Some responses were large even when comparing ungrazed to lightly grazed, or lightly to moderately grazed treatments. Birds appeared to be a particularly discriminating group to the grazing intensity treatments. Differences among grazing treatments in richness of groups other than plants and birds were relatively minor, especially when compared to large declines in abundance of some groups with increasing grazing intensity. For the well-studied groups (plants and birds), shifts in species in terms of 'quality' factors, such as exotic, endemic, rare, generally suggest that livestock grazing may be more similar to conditions this particular system was exposed to in recent evolutionary time than would be the removal of the exotic, domestic grazers that functionally serve as a surrogate to bison.

Trophic structure composition did not vary greatly across grazing treatments. Further, large effects of grazing on some consumer groups did not translate into similarly large effects on ecosystem processes such as primary production or soil nutrient pools or cycling rates.



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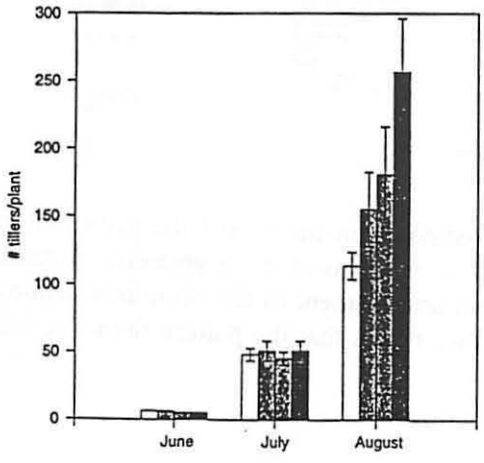
Minnick, Tamera J., and Debra P. Coffin. Common garden study of *Bouteloua gracilis* and *Bouteloua eriopoda* at the Central Plains Experimental Range in northern Colorado.

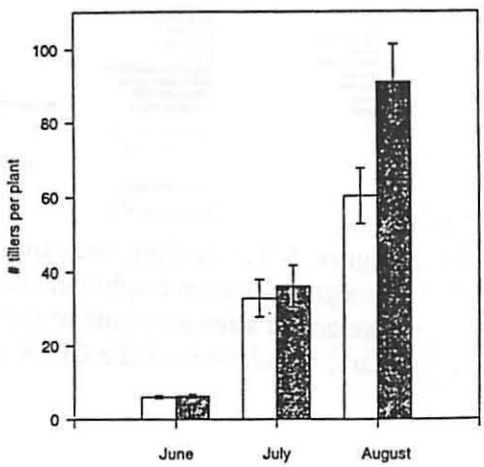
We evaluated differences in growth, phenology, and reproductive output between seedlings of *Bouteloua eriopoda* and seedlings from two seed sources of *B. gracilis* grown with and without warming chambers in a common garden at the Central Plains Experimental Range (CPER) in northern Colorado. *Bouteloua gracilis* is a dominant of the shortgrass steppe and the CPER and is found throughout the central grasslands region of the U.S.; whereas *B. eriopoda* is a dominant in desert grasslands and is confined to the southwestern U.S., found only as far north as southern Colorado. This study was designed to elucidate mechanisms for the exclusion of *B. eriopoda* as far north as the CPER and to compare phenotypic variation in growth and reproductive output of two populations of *B. gracilis*. We used warming chambers to increase growing degree days to detect if growth, seed production and viability, and/or winter mortality are linked to environmental conditions at the CPER for *B. eriopoda* and the two phenotypes of *B. gracilis*. Chambers increased daily maximum temperatures an average of 4°C and nightly minimum temperatures an average of 1°C. We found that measures of both growth (tiller number and length of longest tiller) and reproductive output (seed stalk, seed head and seed weight, number of flowering culms and seed heads per culm) were lower for plants inside of the warming chambers compared to plants outside the chambers. This may be due to increased evaporation in the warming chambers due to increased temperatures, and thus lower water availability for transpiration and growth. The *B. gracilis* plants from seed collected at the CPER showed slower growth rates than plants from seed collected at the Sevilleta. There were larger differences in reproductive effort between plants inside and outside the warming chambers for Sevilleta *B. gracilis* plants compared to CPER *B. gracilis* plants. Seed viability is currently being measured, and winter mortality will be recorded in the 1996 growing season.



***B. gracilis*: Number of tillers per plant through time**




***B. eriopoda*: Number of tillers per plant through time**



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Integrating community structure, ecosystem processes, and system stability with the soil food web of the Shortgrass Steppe

Our research has focused on how ecosystems structure and function are altered by natural and anthropogenic disturbances. Disturbance has been shown to affect the cycling of nutrients and the trophic interactions within ecological communities. Separate from the field and laboratory studies, modelling studies have demonstrated that altering community structure or processes within the community affects system stability. What is missing is a clear illustration of the mechanism that links community structure, nutrient dynamics and stability. Our aim is to determine whether current observations that nutrient retention and community structure are rooted in system stability. Our working hypothesis is that changes in nutrient retention and community structure that follow disturbance are the result of changes in the pattern of interaction strength within a community (Figures A and B). Field data from the CPER reveal an interesting pattern between nitrogen flow between soil organisms and the interaction strengths (Figure A). At the base of the food web, the negative effects of predators on prey are disproportionately large compared to the positive effects of prey on predators, while the reverse is true at higher trophic positions. This asymmetry of interaction strengths with trophic positions is more stable than a random arrangement of the same pairing of interaction strengths with trophic position (Figure B). We predict that systems that have been disturbed and exhibit lower nutrient retention would possess patterns of interaction strength that are less likely to generate a stable ecosystem. We propose two models to describe what happens to ecosystems following disturbance - The **Stable Transition Model** and **Punctuated Stability Model**. We are currently applying the approach described above to the data collected from the Grazer-Enclosure-Exclosure study that is underway at the CPER.

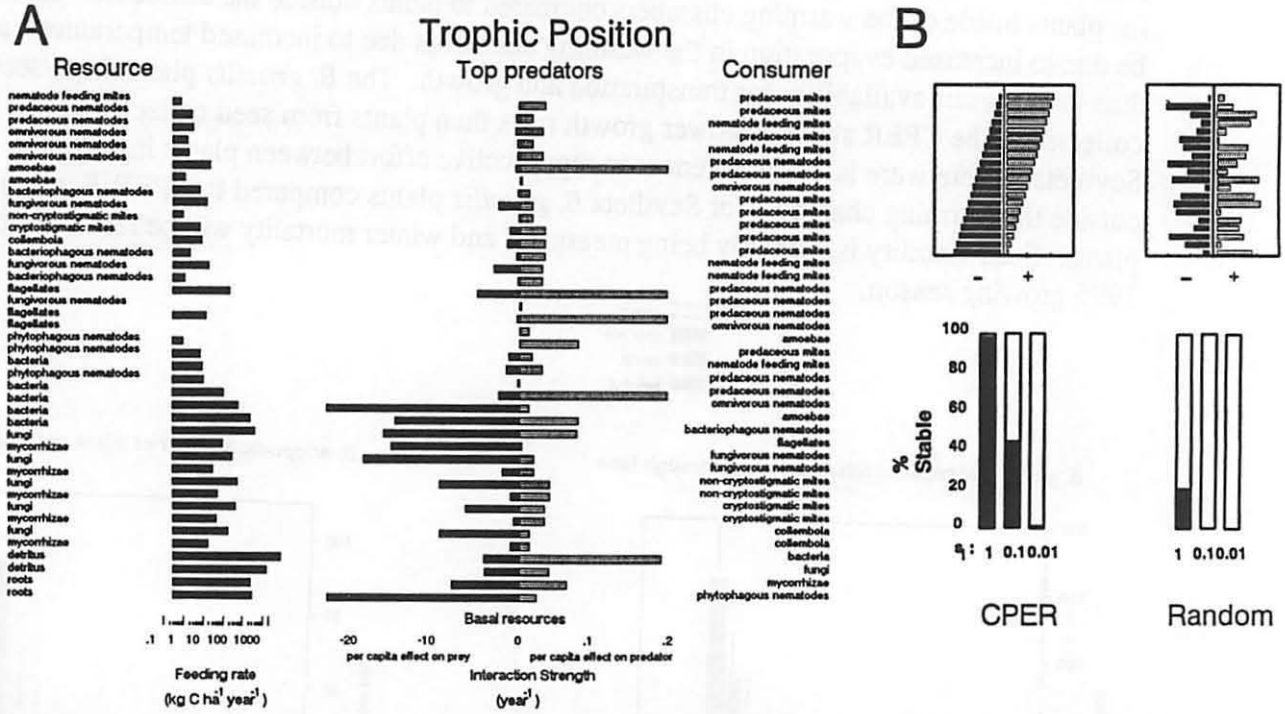


**Figure A** The feeding rates from prey (resource) to predators consumers and the paired interaction strengths for each trophic interaction. **Figure B** Stylized versions of the asymmetric patterning of interaction strength found at the CPER and the Random arrangement of the same interactions. Monte Carlo simulations of the CPER and Random communities reveal that the pattern favors stability.

SUMMARY FORM: 1996 CPER SYMPOSIUM


| | | |
|---|---|---|
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Parton, William J. and Romel Lapitan. Seasonal patterns in water budget and microclimate at CPER.


Microclimatic data has been observed hourly at CPER site since 1986. Seasonal variation in the microclimate data have been analysized and will be presented for specific years. The variables include total shortwave and net radiation, soil and air temperatures, precipitation, wind speed and direction, relative humidity, and actual evapotranspiration. Precipitation showed wide variations between years which resulted in year to year variance in actual evapotranspiration patterns. Generally the highest actual evapotranspiration rates occurred during May and June, while the lowest values occurred during the winter. Analysis of the lysimeter derived precipitation data showed that 8 to 10 percent of the total annual precipitation came from small precipitation events. Midday sensible heat flux was found to be linearly related to the difference between the 2.5 cm soil temperature and the 2 m air temperature. This correlation was used to develop a method for estimating daily evapotranspiration based on the energy budget approach. The lysimeter data was used to calculate seasonal water budgets which showed large year to year variations in the water budgets. During the non-growing season there was a net accumulation of soil water during all of the years with most of the water being stored during the fall and spring time periods. Water stored during the non-growing season is lost due to evapotranspiration during May and June and precipitation received during the July through October period is lost due actual evapotranspiration during that time period.

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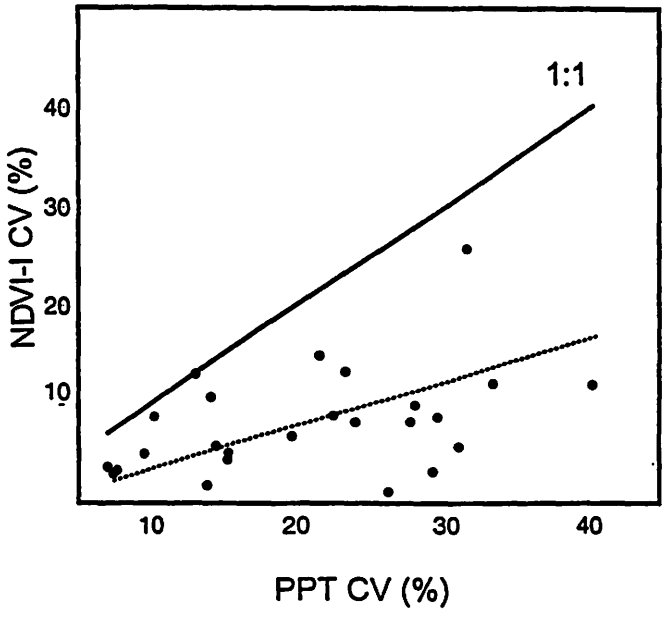
Paruelo, J.M. and W.K. Lauenroth. Interannual variability of the NDVI curves and their climatic controls in North American shrublands and grasslands

We analyzed the year-to-year variability of different characteristics of the seasonal dynamics of NDVI and their relationships with climatic variables for grassland and shrubland sites of North America. We performed the analyses for 25 sites spread across grassland and shrubland areas of North America. The sites selected corresponded to relatively undisturbed areas. We analyzed for each site the variability of 7 traits derived from the annual NDVI curves: the annual integral, the difference between maximum and minimum NDVI, the dates of the inflection points of a double logistic model fitted to the NDVI curve, the difference between these dates, the date of maximum NDVI, and the coefficient of determination of the double logistic model .

The temporal variability of traits that integrated aspects of primary productivity over the year showed a lower variability than those related to seasonality. This suggests that from year-to-year, grassland and shrubland ecosystems would differ more in the timing of production and senescence than in the total amount of carbon fixed. The integral of NDVI (NDVI-I) showed less temporal variability than annual precipitation (PPT). The CV of both precipitation and NDVI-I were positively related. The slope of the relationship was significantly lower than 1, indicating than the variability of ecosystem function is a lower proportion of the variability of annual precipitation in areas with a high relative variability of this climatic variable than in areas of low variability.



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J.D. Reeder, G.E. Schuman, G.F. Frasier, and R.H. Hart. Utilization of municipal, industrial and animal wastes on semiarid rangelands.

Rangelands are being considered as potential sites for disposal of municipal, industrial and animal wastes. However, little information is available concerning the application of waste materials to rangelands where incorporation into the soil is not feasible, and where the vegetation consists of perennial grasses rather than annual crops. We applied industrial, municipal and animal wastes to semiarid rangelands to determine short- and long-term changes in soil, plant and water quality properties. Fresh feedlot manure, composted feedlot manure, dry sewage sludge from Cheyenne WY, and phosphogypsum (a by-product of the P fertilizer industry) were applied in May, 1993, at a rate of 22.4 Mg/ha to plots established in pasture 11N of the Central Plains Experimental Range. This paper reports changes in aboveground plant biomass over three years following waste application. In 1993, plant biomass increased by 43% with applications of composted manure or dried sewage sludge, reflecting the high levels of N and P added by these amendments. Increases were due primarily to increases in warm season grasses, and secondarily to increases in fringed sagewort (*Artemisia frigida*) and annual forbs. Cool season grasses and perennial forbs were not affected by any of the waste treatments. In the spring of 1994, 67 kg/ha fertilizer N ($NH_4NO_3$) was added to half of the plots treated with phosphogypsum. However, drought throughout the 1994 growing season limited plant response to this added fertilizer N or to residual N and P from the waste amendments. In 1995, a cool, wet spring and early summer increased biomass production of cool season grasses, annual forbs, and fringed sage; production on control plots was 46-83% higher than in the previous two years. The increase in fringed sage production was from new seedlings germinating during the period of extended wet weather. Biomass production on the composted manure and sewage sludge plots remained significantly higher than production on control plots, but most of this increased production was due to annual forbs (850-1000 kg/ha).

We will continue to sample vegetation and soil for a minimum of two more years.

1995 Aboveground Dry Matter Production, kg/ha

| | Control | Fresh Manure | Composted Manure | Sewage Sludge | Phosphogypsum | Phosphogypsum +N |
|---|---|---|---|---|---|---|
| Annual Forbs | 212 | 286 | 1037 | 847 | 102 | 345 |
| Perennial Forbs | 78 | 45 | 45 | 133 | 54 | 390 |
| Cool Season Grasses | 176 | 264 | 752 | 405 | 273 | 180 |
| Warm Season Grasses | 730 | 799 | 538 | 928 | 519 | 1184 |
| Fringed Sage | 467 | 586 | 350 | 400 | 51 | 176 |
| TOTAL | 1663 | 1979 | 2721 | 2714 | 999 | 2275 |

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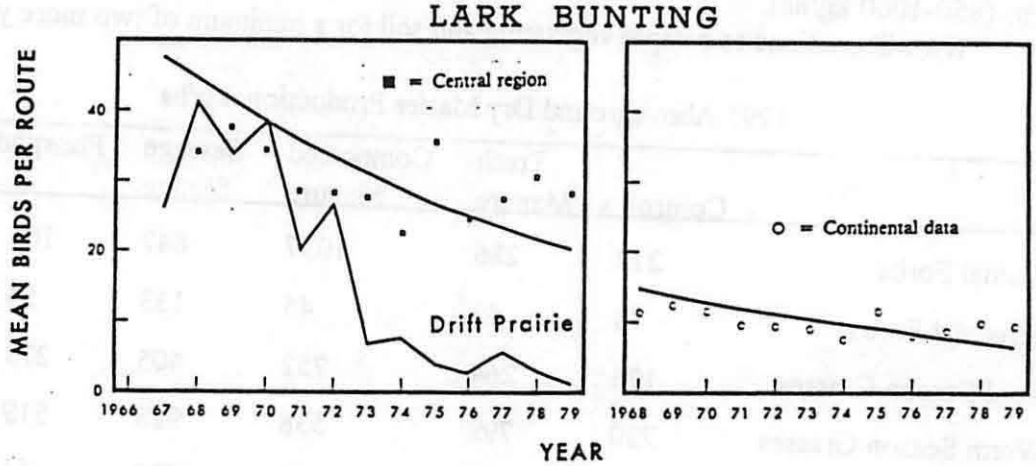
Ryder, Ronald A. Summer trends in bird populations on the Central Plains Experimental Range and nearby areas.

A standard North American Breeding Bird Survey was made on 15 June 1995. This is the seventeenth annual count made over the same route since 1968. All individual birds seen or heard during a 3-minute period are recorded at each of 50 stops at ½ mile intervals along a 24½ mile long route starting at the junction of U.S. 85 and Weld County Rd. 114. Data are recorded on standard U. S. Fish and Wildlife Service forms. Results are on file at the Patuxent Wildlife Research Center, Laurel, Maryland, and in the LTER data base at CSU. Approximately 84% of the total individuals (11,779) observed in the 17 years were of 3 species: Lark Bunting (32.9%), Horned Lark (25.5%) and Western Meadowlarks (16.0%). Total number of species has ranged from 18 to 28 (mean, 21.6). Twenty-two species and 586 individuals were noted in 1995. Lark Buntings and Horned Larks showed a continued decline from peaks in the 1960s and '70s. Western Meadowlarks and McCown's Longspurs were closer to the 17-year average. No Mountain Plovers have been recorded on the annual BBS route since 1985, whereas regularly 10 to 30 were counted 1969-1978. Mountain Plovers have shown similar declines nationally and are proposed to be listed as a threatened species. Mourning Doves, the only game species reported annually on the CPER, were below normal in 1994 (39 individuals) and in 1995 (33 individuals) along the BBS route, in contrast to peaks in 1990 (68 individuals) and 1991 (70 individuals). In 1995 low numbers of individuals of all species is believed due to the cooler and wetter weather. Results will be compared with those from the Briggsdale BBS route, where 28 continuous years of data are available. Maps and graphs will relate the CPER findings to those from 1,800+ other BBS routes in North America.




Decline of Lark Buntings in North America based on 94 BBS routes.

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|---|---|
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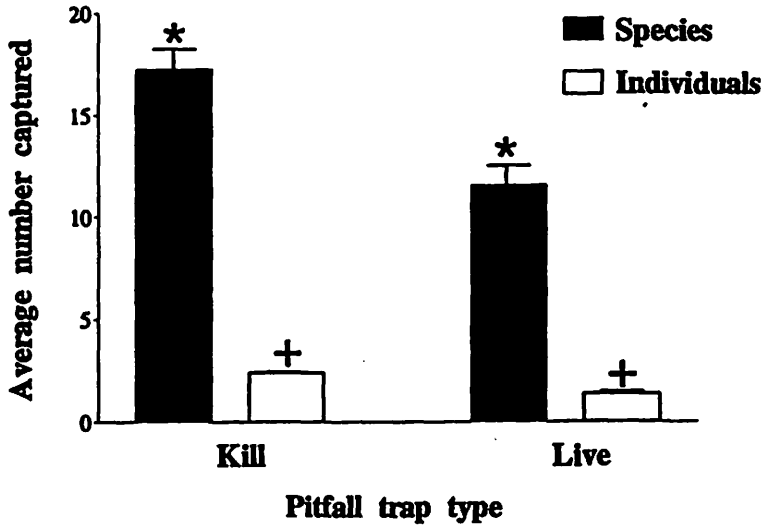
Weeks, R.D., and N.E. McIntyre. A comparison of two arthropod collection techniques.


The efficacies of two arthropod collection techniques (live pitfall trapping and kill pitfalling with propylene glycol) were compared on the shortgrass prairie of north-central Colorado. Kill pitfall traps caught significantly more taxa and individuals overall than did live pitfalls, but this effect was mediated by high variance in the capture rates of most species. Differences between the two trap types were attributed to potential attractant properties of the propylene glycol because the same number of individuals per species was caught in both trap types for those taxa that were collected in both trap types, indicating that better retention of captured arthropods by the killing agent was not responsible for the differences observed. Because of species-specific differences in trap efficiency from presumed non-neutral properties of the killing agent and because kill pitfalling indiscriminately eliminates more than just the target taxa, live pitfall trapping is recommended over kill pitfalling with propylene glycol.


**Mann-Whitney U test:**

* P = 0.0421

\+ P = 0.0024

# 1996 CPER Symposium
# Poster Session Organization

We will feature roughly half of the posters in the morning, and half in the afternoon, although all will be displayed during the entire period. There will be two separate discussions in the morning, and two in the afternoon, related to the posters shown during that time. The questions we will address in the discussions are:

> ***-What are we learning that is important for science and management with our current research?***
> ***-What are the important issues and unanswered questions in this area?***
> ***-What are the crucial management needs in this area?***

Please try to see the posters related to the discussion you will participate in.

## Morning Poster Session and Discussions:

Session 1: Herbivory
*Posters:*
Burke
Cibilis
Fraleigh
LeCain
Milchunas
Moore

***Discussion Facilitator:***

Session 2: Water and Energy Dynamics
*Posters:*
Dodd
Frasier
Liston
Parton
Paruelo

***Discussion Facilitator:***

## Afternoon Poster Session and Discussions

Session 1: Populations and Processes
*Posters:*
Coffin
Fitzgerald I and II
Fraleigh
Milchunas
Minnick
Moore
Peterson
Ryder
Weeks

***Discussion Facilitator***:

Session 2: Biogeochemistry
*Posters:*
Barrett
Bisbee
Burke
Epstein
Gill
Hook
LeCain
Martin
Reeder

***Discussion Facilitator***:

## Additional CPER Symposium

## Participants

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|---|---|
| Dave Bigelow | USDA UV-B Monitoring Program and Natural Resource Ecology Laboratory |
| Jim Dahl | CSU- Atmospheric Science Department |
| Bill Durham | USDA UV-B Monitoring Program and Natural Resource Ecology Laboratory |
| Jace Fahnestock | CSU- Graduate Degree Program in Ecology |
| Jim Gibson | CSU- Natural Resource Ecology Laboratory |
| Pam Lyman | USDA-ARS Crow Valley Livestock Coop, Inc. |
| Larry Rittenhouse | CSU- Rangeland Ecosystem Science Department |
| Rebecca Roof | USDA-ARS Natural Resources Research, Rangelands |
| Bob Schooley | CSU-Biology Department |
| Howard Skinner | USDA-ARS Great Plains Systems Research |
| Dave Smith | |