2000 SGS-LTER Progress Report

I. RESEARCH

During 1999 and 2000 we produced 88 papers in refereed journals, 33 book chapters, 7 dissertations and 20 abstracts from national and international meetings. Nineteen graduate students and 28 undergraduates work on research related to the shortgrass steppe LTER. We continue to sample our long-term projects and initiate short-term experiments. Following are some research highlights for 1999-2000 in each of our core areas including: Populations and Processes, Biogeochemistry, Paleoecology/Paleopedology, Disturbance, and Water and Energy Dynamics.

1. Populations and Processes

Plants

Exotic species invasions along roadways: In cooperation with the Colorado Experiment Station, we completed a survey of exotic plants in the western section of the Pawnee National Grasslands. We surveyed roadsides and upland steppe with the objective of assessing which exotic plants were present along the roads in the western section and whether they have invaded the upland steppe. Our results suggest that exotic plants are abundant along the roadsides throughout the national grassland, but that almost none of them have invaded the steppe. We found 74 total species along roadsides and 45 in the open steppe. Twenty-six or 35% of the roadside species were exotics and 5 (11%) of the upland steppe species were exotics. Most of the exotic species found on the roadsides (19 out of 26) were non-grass species while in the upland steppe the exotics were approximately evenly split between grasses and non-grasses. It appears from this work that roadsides are playing the role of corridors allowing exotic plants to penetrate much more deeply into the Pawnee National Grassland than would occur in their absence. While none of the current exotic plants pose much of an invasive threat, that could change in the future as new plants are introduced into the area.

Cactus as biogenic refuge: Previous research has shown that spiny clumps of the cactus *Opuntia polyacantha* provide biogenic refuges from cattle grazing for vascular plant cover and seedhead production on shortgrass steppe. The objective of the present study was to determine the conditions that favor these positive effects of *Opuntia* clumps. We analyzed the positive effects of *Opuntia* clumps in a range of environments with different local grazing intensity, soil texture, and clumps characteristics (size and density of the clumps, and cladode cover within clumps). We also analyzed the potential interactions between *Opuntia* clumps and the presence of other larger plant refuges (wire exclosures). The effects of *Opuntia* clumps were studied in eight replicate long-term moderately grazed pastures and in their respective ungrazed controls, established 60 yrs ago on shortgrass steppe of the Great Plains, Colorado, USA. We considered the difference in cover and seedhead production between inside and outside *Opuntia* clumps in the grazed treatment to be an indicator of the cactus effect, and we used "relative cover" or "relative seedhead production" to refer to these differences.

The positive effect of *Opuntia* clumps on relative seedhead production by the dominant species in the community (*Bouteloua gracilis)* was associated positively with local within pasture variability in cattle grazing intensity. Positive effects of *Opuntia* clumps on the relative vascular plant cover appeared to be linked to long-term grazing treatments more than short-term cattle grazing intensity, suggesting that these refuge effects might be more important under

management practices with persistent cattle stocking rates. Soil texture affected the intensity of the positive effects of *Opuntia* on the relative vascular plant cover, but had no affect on relative seedhead production. Positive effects of *Opuntia* on the relative cover of cattle-preferred species and cool-season perennial grasses were greater on soils with greater clay content. These results suggest that the refuge effects are more intense under conditions of low productivity in this semiarid grassland. Clump size and density appeared not to influence the effectiveness of *Opuntia* as a refuge. Cladode cover within the clumps (proximity of spiny cladodes) exerted positive effects on some functional groups, but had negative effects on others by reducing available space. Positive effects of this cactus might also depend on the presence of other types of larger plant refuges. Positive effects of *Opuntia* clumps on plant diversity and on the abundance of some functional groups (forbs, cool-season perennial forbs, and barrel-shaped cacti) were positively associated with the diversity and the abundance of these functional groups in other refuges (long-term wire exclosures) located in the proximity of the *Opuntia* clumps. Our results support the hypothesis that *Opuntia polyacantha* clumps provide mechanisms important to persistent of the shortgrass plant community, and that these mechanisms play a more prominent role under harsh conditions (persistent heavy cattle grazing pressure and low productivity).

Animals

Animal Monitoring Programs: Since 1994, we have estimated population sizes of nocturnal small mammals, rabbits, and, to a lesser degree, terrestrial carnivores, on the SGS-LTER site in north-central Colorado. These monitoring programs continued in 1999-2000, including live-trapping studies in May and roadside counts of rabbits and canids in October, January, April, and July. We continued monthly warm-season surveys of terrestrial macroarthropods, studies that were also initiated in 1994. Captures of major insect taxa are counted in 90 pairs of pitfall traps placed along a 1 km topographic gradient as part of new long-term monitoring studies. In addition, we continued arthropod pitfall trapping studies on trapping webs established for monitoring abundance of small mammals. Twenty traps were placed on each of three upland grassland and three saltbush sites. Pitfall traps are run for 4-5 consecutive days on three occasions during summer months to track temporal changes in abundance of arthropods, which are important food items for rodents in shortgrass steppe, as a possible determinant of trends in rodent numbers.

Beginning in July 1997, we modified our roadside census route to include areas of the Pawnee National Grasslands (PNG), taking advantage of the 1996 SGS-LTER site expansion. We have continued to utilize this new route which includes more upland prairie habitats used by white-tailed jackrabbits *(Lepus townsendii)* and swift foxes *(Vulpes velox),* while continuing to allow us monitor rabbit and canid populations on portions of the Central Plains Experimental Range.

Effects of grazing by domestic livestock on bird and rodent communities: These effects are mediated through the impact of the herbivores on plant community physiognomy, productivity, and species composition, although other factors may also be important. Based on a large number of studies, grazing effects on plant communities across a broad geographic range of ecosystems have been shown to increase with increasing aboveground primary productivity and shorter

evolutionary history of grazing. Our objectives in this analysis are to assess whether bird and rodent responses to grazing of North American rangelands are related to factors important in the relative magnitude of vegetation responses, and whether grazing is generally detrimental to less abundant or declining bird species and beneficial to abundant or increasing species.

Bird communities in systems with short versus long evolutionary histories of grazing displayed responses to grazing similar to that of vegetation, but rodents did not. Grazing in systems with short compared to long evolutionary histories of grazing was more likely to alter bird community composition, negatively versus positively affect abundance, and decrease versus little affect richness. Rodent responses were sometimes opposite or highly variable, but there were often species sampled uniquely in more lightly grazed treatments. Bird and rodent responses to grazing along gradients of above ground primary production were also often different. Bird response to grazing displayed an increase in community dissimilarity with increasing primary productivity across grasslands of the Great Plains, but rodents did not. Bird abundance responses to grazing were usually highly positive in productive tallgrass prairie, less positive in low productivity shortgrass steppe and intermediate in mixedgrass prairies. Rodent abundance was usually negatively affected in all Great Plains plant communities, but became increasingly so with increasing plant community productivity. Neither bird nor rodent diversity or richness displayed a clear response relationship with increasing primary productivity, but across all studies the responses to grazing were most often negative. Birds appear to track grazing influences on vegetation more closely than rodents, but neither may be considered more sensitive indicators of grazing impacts than plants except under certain conditions.

With a few exceptions, previous classifications of birds as increasers or decreasers with grazing were supported. Although some bird species were generally either positively or negatively affected by grazing, no rodent genus consistently showed increases with grazing across North American sites, although grasshopper mice and white-footed mice responses were often positive. Some bird and rodent species are considered to have specific, or optimum habitat requirements in terms of vegetation density or height, but there were insufficient data over grazing intensity gradients to assess whether a particular bird species or rodent genus preferred a different grazing management in communities of different productivity. Only a very weak suggestion was found that would suggest less abundant or declining bird species are generally more negatively impacted by grazing than are abundant and increasing species, and there was no relationship for primary grassland species.

Prairie Dog Studies: Prairie dogs (*Cynomys ludovicianus*) influence their surroundings in many ways. These herbivorous mammals change local plant community structure by cropping vegetation, and they modify the soil structure by burrowing and building mounds. These changes in vegetation and edaphic factors may influence insects such as beetles and grasshoppers that live in prairie dog towns. This year we completed a study aimed at understanding the relationship between torpor, environment, and body condition in free-ranging black-tailed prairie dogs. Black-tailed prairie dogs (*Cynomys ludovicianus*) are the only ground-dwelling sciurids ranging north of 40^{o} 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 the 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. We 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. We 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. Our 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. We 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 to those observed in free-ranging hibernators and may explain why black-tailed prairie dogs are unable to hibernate continuously throughout winter.

2. Biogeochemistry

CO_2 Fertilization Study: SGS LTER investigators have successfully received renewal funding for our CO_2 fertilization study, which is also supported by the SGS LTER project. The study utilizes open-top chambers to address three objectives: 1) to determine the impact of doubling CO_2 in shortgrass steppe mixed C_3/C_4 plant communities on net primary production, net ecosystem CO_2/H_2O exchange, C and N allocation both above and below ground, and water and N use efficiency; 2) to determine the impact of doubling CO_2 on soil water and N dynamics on soil water content, C/N distribution in soil organic matter, changes in mineralizable N, NO and N_2O emissions, and consumption of atmospheric CH_4; and 3) to incorporate the knowledge gained from these studies into simulation models that will allow for realistic extrapolation through time and space of soil moisture, nutrient cycling, and plant productivity. Preliminary results from this study indicate that aboveground production in ambient chambers (214 g m^{-2}) exceeded that in control plots (155 g m^{-2}) by 38% for the growing season. Seasonal aboveground production under elevated CO_2 (278 g m^{-2}) was 30% greater compared to that in the ambient chambers. Significant growth enhancements from elevated CO_2 were realized for both C_3 and C_4 grasses. These CO_2-induced growth enhancements were related to improved water relations as well as higher photosynthesis rates. Soil water content was often greater in elevated chambers. Leaf water potentials, determined weekly via pressure chamber, were generally greater in leaves of *B. gracilis* and *P. smithii* grown at elevated CO_2 compared to ambient chambers. Leaf intercellular CO_2 (C_i) photosynthetic response curves indicated that photosynthesis of *P. smithii* was unsaturated at C_i concentrations exceeding 700 L L^{-1}, whereas photosynthesis in *B. gracilis* leaves appeared saturated at approximately 300 L L^{-1} C_i. Photosynthetic capacity of both species was sometimes reduced in plants grown at elevated CO_2, although this response was considerably more noticeable in the C_3 species, *P. smithii*.

Nitrogen and Exotic plant invasions: Exotic plant invasions may be exacerbated by alterations in the global nitrogen cycle, so it is important to compare the effects of nitrogen availability on the growth and competitive abilities of both exotic and native plant species. This study was

conducted to determine the effects of increasing and decreasing nitrogen availability on the growth and competitive ability of two grass species with contrasting life histories, cheatgrass (Bromus tectorum), a North American exotic, and blue grama (Bouteloua gracilis), a North American native. We investigated the effects of nitrogen availability and competition on aboveground biomass, belowground biomass, height, and % nitrogen tissue concentrations by growing the two species in the greenhouse under five levels of nitrogen and five levels of competition. Both species had a significant response to increasing nitrogen availability, with Bromus having a much stronger response than Bouteloua. The exotic species was able to exploit excess nitrogen enrichment, but the native species was not able to expand its growth past a certain level when the excess nitrogen was available. Competition significantly affected both species. Bromus was negatively impacted only by intraspecific competition, while Bouteloua was strongly negatively affected by interspecific competition from Bromus. Reducing available nitrogen suppressed the growth of both species, but did not give the native species a competitive advantage over the exotic species. Our results suggest that the success of efforts that attempt to suppress the spread of exotic weeds by reducing nitrogen availability may depend on the species of weed present.

3. Paleoecology/Paleopedology

Separation of Soil and Vegetation Components of Ecosystem Respiration: As a step towards closing the imbalance in our knowledge of the global carbon cycle, we designed a study of the ^{18}O composition of soil water, soil CO_2, and the flux of CO_2 from soil to the atmosphere. Field data combined with model runs allowed us to identify the depth at which the isotopic composition of the soil CO_2 flux to the atmosphere is derived. Because the study spanned grassland, forest, and tundra systems, results also have potential to lend insight to regional to global patterns of carbon cycling. We found that Soil water ^{18}O values vary as a function of the isotopic composition of precipitation inputs and evaporative losses. Measured values were significantly enriched in the grassland, as compared to forest and tundra systems studied. Incomplete isotopic equilibration between CO_2 and water was often observed under field conditions. This was especially true under dry conditions, such as those commonly observed at the Central Plains Experimental Range Long-Term Ecological Research sites. The incomplete equilibration of CO_2 and water near the soil surface is important because it suggests that ^{18}O can be used as a marker to separate soil and vegetation components of ecosystem respiration from these systems. Soil moisture status, in part controlled by soil texture and structure, affects both the isotopic composition of respired CO_2 and the degree of fractionation that takes place as that CO_2 diffuses out of the soil profile

Studies of Paleoenvironment: To date we have expanded our paleoenvironmental studies to the eastern extreme of the Pawnee National Grasslands. Based on last years reconnaissance work we have discovered that the geologic substrate and Pleistocene terrace expression differ significantly in the eastern sector of the PNG relative to findings at the CPER (located in the extreme western portion of the SGS). We have sampled and characterized six alluvial terraces that date back to 600K years and are currently evaluating mineralogical and isotopic data. We are also applying our current working model of Holocene landscape development to this portion of the grasslands and have selected and sampled two stratigraphic sites that will allow us to evaluate a continuous record of Holocene paleoclimate in the eastern margins of the SGS.

Biogeochemistry of Si in Grasslands: The main goal of our research is to locate and characterize this 'interface' between the terrestrial components of the Si-cycle. Surface processes such as clay mineral formation associated with weathering and phytolith formation, as described above, are the most likely candidates for such an interface. They are relatively long-term terrestrial sinks of silicon. However, prior to assessing these processes with respect to their geochemical contribution to the Si-cycle, experimental studies were conducted to determine the magnitude and direction of their isotopic fractionation. Analyses of clay minerals and phytoliths grown under controlled conditions in the laboratory have yield interesting results. Phytoliths and clay samples all fractionate in the negative direction? We are continuing to monitor ^{30}Si values of clay minerals, phytoliths, and the waters from our climatic transects in the Great Plains and we are also measuring the ^{30}Si values of the soil or rock they originated in.

Knowledge from the controlled studies will be tested in a relatively well-constrained Earth surface process environment by sampling and analyzing soil/parent rock, soil-water, phytolith, and weathering clays from LTER various sites. Specifically, we suspect that as long as Si in soil solution is primarily derived from weathering of rock, the ^{30}Si values of clay, phytoliths, and leaching water should remain relatively constant and be defined by the fractionation between primary rocks and secondary (inorganic or biogenic) minerals. As soils age, primary minerals will become a less dominant source of Si, leading us to hypothesize that the ? ^{30}Si values of the then newly formed clay minerals and phytoliths will evolve in a more negative direction, driven by the release of Si from previously formed ('first-generation') clay minerals and phytoliths.

4. Disturbance

In 1997, the LTER and the USFS initiated a fire study with the dual objectives of assessing the use of fire as a management practice to increase nesting habitat for mountain plovers, and examining the effects of fire on plant community structure and productivity. Fire is an integral component of many productive grassland ecosystems such as the tallgrass prairie of the North American Great Plains. A large number of comprehensive studies on fire effects have been conducted in these systems. Because of the low fuel loads, pre-settlement fires probably affected less extensive areas in systems such as the shortgrass steppe. However, small lightning fires may have been frequent in shortgrass steppe, and fire impacts in this system are poorly understood. Studies of fire effects in grasslands somewhat similar to shortgrass steppe suggest a potential loss of productivity in dry years following a fire. We continue to sample this study.

5. Water and Energy Dynamics

Effects of Land Conversion on Water Balance: As part of our interest in the effects of conversion of a large portion of the shortgrass steppe to summer-fallow wheat fields, we have just completed (with major funding from an EPA STAR grant) the first phase of a comparison of the effects of this conversion on water balance. Under both native steppe and wheat, soil water contents are lowest in July and August and highest in May and June. Native steppe plants appear to be more effective than wheat at extracting soil water during the growing season especially below 30 cm. Fallow fields had the highest soil water contents but much of the extra water was stored at depths not accessed by the wheat crop. Water in the top 30 cm of the soil was most completely used by the wheat crop and was also most heavily affected by evaporative losses

during the fallow year. Our results suggest that the fallow rotation system is a very inefficient way to store water for subsequent use by wheat.

Water Balance and the Carbon Cycle: To understand carbon dynamics, the water budget in the soil, and the evaporative and transpired fluxes of water vapor from the ground surface and vegetation must be understood. We have reported on this coupling for the central Great Plains in Lu et al. (2000) and Eastman et al. (2000), where an atmospheric (RAMS) and two separate biogeochemical models (CENTURY and GEMTM) were used. One conclusion that has resulted from these studies is the sensitivity of seasonal weather forecasts over the short grass steppe to soil moisture at the beginning of the growing season. Dry conditions produce a reduction of rainfall from what otherwise would occur. Spatial variations in temperature in the SGS region of northeast Colorado also appear to be closely related to soil moisture and vegetation greenness spatial structure. Such conclusions require that climate be considered a coupling of land, atmosphere, ocean and sea ice conditions, rather then being driven primarily by atmospheric processes.

Land Use Type and Seasonal C Storage: For the past 3 years, bowen ratio/energy balance stations have been used to monitor fluxes of CO_2 and H_2O at the shortgrass steppe LTER site as well as in a northern mixed prairie located 40 miles to the north of the LTER site at the USDA-ARS High Plains Grasslands Research Station. This past year we have begun to analyze and summarize our findings from these two grassland sites. We've found that C is being stored in both of these grasslands (during 1998 growing season, 138 g C stored in shortgrass steppe vs. 49 g C stored in northern mixed prairie), and suspect that the wetter than normal weather patterns of the past 10 years has favored C storage in these grasslands. Seasonal and site-related patterns of C assimilation were controlled to a large extent by soil water dynamics. These findings differ from results from a nearby winter wheat field in which a bowen ratio/energy balance station indicated a loss of C over a two year period, and suggest these intact native grasslands may have a superior capacity to store C. In a new study, three bowen ratio/energy balance stations were installed in late March at the shortgrass steppe site in adjacent 1/8 section pastures. The pastures will all be moderately grazed this year to establish baseline data, and next year three grazing treatments will be imposed: no grazing, moderate grazing, and heavy grazing. In addition to monitoring CO_2 and H_2O fluxes, collaborators will collect soil C and N data, plant growth and developmental data, and remotely sensed data from aircraft and satellite to evaluate rangeland condition and to compare with flux data.

II. INFORMATION MANAGEMENT

The SGS-LTER information management team has changed. Chris Wasser, Project/Information Manager has left after four years with LTER. Robin Kelly, our current Project Manager, works to support over fifty field research projects. Nicole Kaplan and Laurel Hartley, our current Field Crew Managers, have worked closely with SGS-LTER researchers, conducted field research experiments, and managed, trained, and supervised field research assistants for the past three years. They are now moving into the roles of Data and Collections Managers. Martha Coleman, GIS Manager, continues to manage our spatial data and implement web-based displays of information. Computer information systems experts from Colorado State University (CSU) provide technological support for computing, networking, and developing improvements and expansions to our website. We have put together an information management team that will be

successful because they work with researcher(s) from project initiation, through implementation, data processing, analysis, and publication of data and results. It is our goal to dramatically improve the availability of online datasets in the next year.

Geographical Information Systems: During this year, GPS technology was used to generate new and update existing GIS data layers on the SGS-LTER site. For the Central Plains Experimental Range portion of the site, both LTER and ARS personnel collected GPS-based road and fence line data in cooperation with the ARS to provide comprehensive map layers for field use. Buildings and landmark locations were also updated using GPS. As of July 2000, approximately 80 percent of our current short term and all long term research sites on the CPER and PNG have been mapped using GPS. The remaining sites are to be mapped using GPS during the fall portion of the 2000 field season. New data layers that were acquired from public agencies for the site include: geology, watersheds, and Public Land Survey.

This year, our site migrated all GIS library data from NAD27 datum to NAD83 datum, and we are now using this new datum as the standard for our work. In practice, this means that the NAD27-based data is offset approximately 200 meters south of the NAD83-based data. The new datum is most compatible with our GPS data collection process and the newer data distributed by public agencies such as the USGS, NRCS and EPA.

Computing and Networking: The SGS-LTER field research station was reorganized to create a computer lab that supports researchers, graduate students, and visiting scientists. Our research station is now connected to a Dell PowerEdge 2300 Server on the CSU campus, which allows pre-approved access to our database from the field station. The NT machines at the research site also are networked and help us to manage project information. The SGS-LTER database, including datasets and metadata dating back to the US/IBP Grassland Biome Program in 1969, are being managed in Microsoft Access. This will facilitate the ability to access and query our database from our website. A new disk array (RAID 5) was purchased to implement enhanced organization and storage capabilities for projects in progress. The new data organization and storage system provided increased available disk space and improved access efficiency.

III. OUTREACH ACTIVITIES

Education: In the past year we have continued our Research Experience for Undergraduate (REU) program with three students working on the following projects: 1) Investigation of the carbon and nitrogen dynamics of buried paleosols in the shortgrass steppe, 2) Genetic variation in regional black-tailed prairie dog populations, and 3) Use of isotopic ratios of oxygen to determine if grasses, shrubs, and trees on the Pawnee Buttes utilize different sources of water.

With funding from NSF-DUE (spring 1998), we continue to build on the Schoolyard LTER concept and improve ties with each of our participating schools. Representatives from SGS-LTER have visited many of the participating schools to help with experimental design and to introduce the LTER concept to the students. We have an immediate goal of getting a Schoolyard LTER web site up and running to allow the participating schools to share information and request input from SGS-LTER scientific staff.

The Research Assistantships for Minority High School Students (RAMHSS) program was highly successful again this year, providing research experiences to students who would otherwise not have the opportunity.

Field Trips and Other uses of the Shortgrass Steppe LTER field site: One of the important contributions we make in the area of outreach is to lead field trips for interest groups to our research site. This year, we had great attendance at a field day aimed at members of non-profit organizations and federal agencies. Audubon Society, Sierra Club, Southern Plains Land Trust, Colorado Division of Wildlife, National Wildlife Federation, Agricultural Research Service, Defenders of Wildlife, Nature Conservancy, Forest Service, Boulder County Open Space, Weld County Open Space, and the Crow Valley Grazing Association. In addition, we had visitors from around the nation and world from both Universities and other organizations.

Landmark Volunteers: This August 10 high school students visited the Shortgrass Steppe LTER as part Landmark Volunteer's program, which engages students in two-week work projects across the country. The students were housed at our field station and spent two weeks assisting LTER and ARS personnel with various duties.

IV. CROSS-SITE, SYNTHESIS, AND NETWORK-LEVEL ACTIVITIES

We have initiated and continued a number of new cross-site and synthesis studies over the past year.

Cross-Site and Regional Analysis Research Highlight: Cross-site and Regional analyses have shown that ecosystem pools of carbon (C) and nitrogen (N) increase as precipitation increases from the semi-arid shortgrass steppe to the tallgrass prairie of the Central Great Plains. Models based on our functional understanding of biogeochemical processes predict that ecosystem C and N fluxes also increase across this community gradient; however, few field flux data exist to evaluate these predictions. We measured decomposition rates, soil respiration, and in situ net nitrogen mineralization at five sites across a precipitation gradient in the Great Plains region. Soil respiration (SResp) and the decomposition constant, k, for common substrate litter bags were significantly higher in the sub-humid mixed and tallgrass prairie (growing season average mid-day SResp = 7.20 mol CO_2 m^{-2} sec^{-1}, k = 0.66 yr^{-1}) than the semi-arid shortgrass steppe (SResp = 4.55 mol CO_2 m^{-2} sec^{-1}, k = 0.32 yr^{-1}). In contrast, in situ net nitrogen mineralization was not significantly different across sites. The C flux data concur with predictions from current biogeochemical models; however, the in situ net nitrogen mineralization results do not. We hypothesize that this discrepancy results from the difficulties associated with measuring in situ net nitrogen mineralization in soils with vastly different immobilization potentials.

Cross-Site, Regional, and Synthesis Publications:

Journal Articles: Burke et al. 1999, Campbell et al. in press, Delgrosso et al. in press, Eastman et al. in review, Epstein et al in press, Eitzinger et al. in press, Groffman et al. in press, Gutmann et al. in review, Hook and Burke in press, Jackson et al. 2000, Kelly et al. 2000, Kotanen et al. 2000, Kroeze et al 1999, Lane et al. 2000, Lauenroth et al. 1999 and 2000, Lu et al. in press, McGuire et al. in press, Milchunas and Lauenroth 2000, Murphy et al. in review, Ojima et al. in press, Paruelo et al. 1999, Pielke et al. in review, Schimel et al. 2000.

Book Chapters: Aber et al. 1999, Burke 2000, Lauenroth et al. in press, Lauenroth in review, Moore and deRuiter in press, Morgan et al. 1999, Mosier and Kroeze 1999, Parton et al. in press, Sala et al. in press.

Network activities: We continue to be very active in network activities. Roger Pielke (LTER investigator) is taking the lead on the cross-site modeling project with San Diego computer center. Burke serves on the Coordinating Committee and the Executive Committee, as well as the new Scientific Synthesis committee for the network.

V. PUBLICATIONS

1999-2000 publications

Journal Articles:

Adler, P.B. and W.K. Lauenroth. Livestock exclusion increases the spatial heterogeneity of vegetation in the shortgrass steppe, USA. (in review)

Adler, P.B., D.A. Raff, and W.K. Lauenroth. Effects of grazing on the spatial heterogeneity of vegetation. (submitted)

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Chase, T.N., R.A. Pielke, T.G.F. Kittel, J.S. Baron, and T.J. Stohlgren. 1999. Potential impacts on Colorado Rocky Mountain weather due to land use changes on the adjacent Great Plains. *Journal of Geophysical Research: atmospheres 104:16673-?*

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de Ruiter, P.C., A. Neutel, J.C. Moore. 1999. Biodiversity in soil ecosystems- the role of energy flow and community stability. *Applied Ecology*. **10**: 217 - 228.

Del Grosso, S.J. W.J. Parton, A.R. Mosier, D.S. Ojima, W. Borken, P.M. Crill and H. Papen. General CH_4 oxidation model and comparisons of CH_4 oxidation in natural and managed systems. Global Biogeochemical Cycles (In Press).

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