Preview of Award 0823341 - Annual Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	0823341
Project Title:	Konza Prairie LTER VI: Grassland Dynamics and Long-Term Trajectories of Change
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Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Recipient Organization:	Kansas State University
Project/Grant Period:	11/01/2008 - 10/31/2014
Reporting Period:	11/01/2012 - 10/31/2013
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

*** What are the major goals of the project?**

The Konza Prairie LTER Program (KNZ) is a comprehensive, interdisciplinary research program with the overarching goals of contributing to conceptual and theoretical advances in the field of ecology, and providing a mechanistic and predictive understanding of ecological processes in mesic grasslands. KNZ also supports numerous educational, training and outreach activities, contributes knowledge to address land-use and management issues in grasslands, and provides infrastructure and data in support of scientific pursuits across a broad range of disciplines.

Our core research site is the Konza Prairie Biological Station (KPBS), a 3487-ha area of native tallgrass prairie in the Flint Hills of NE Kansas. KPBS was established in 1971 and joined the LTER network in 1981. LTER funding supports collection of long-term data on processes such as hydrology, nutrient cycling, plant productivity and community composition. These long-term records provide unique insights into the dynamics of tallgrass prairie ecosystems and a critical baseline for identifying and interpreting ecological responses to environmental changes, and are available as a resource for the broader scientific community. The KNZ program encompasses studies at, and across, multiple ecological levels and a variety of spatial and temporal scales. Our unifying conceptual framework focuses on fire, grazing and climatic variability as essential and interactive factors determining the structure and function of mesic grasslands. The interplay of these natural disturbances leads to the high species diversity and complex, non-linear behavior characteristic of these grasslands. Because grazing and fire regimes are managed in grasslands worldwide, KNZ data are relevant for understanding grasslands globally, and for addressing broader ecological issues such as productivity-diversity relationships, disturbance and community stability, top down vs. bottom up controls of ecological processes, and the interplay of mutualistic and antagonistic biotic interactions. In addition, because human activities are directly (management of grazing and fire) and indirectly (changes in atmospheric chemistry and climate) altering key ecological drivers in these grasslands, we can use KNZ studies and data to address critical issues related to global change, including the ecology of invasions, land-use and land-cover change, human activities and water quality, and ecosystem responses

to climate change. Thus, the KNZ program initiated 30 years ago to understand the effects of natural disturbances in this grassland, now has additional and immediate relevance for understanding and predicting the consequences of global change taking place in grasslands around the world.

A major aspect of KNZ LTER activities is the continuation of our core watershed-level fire and grazing studies, and associated long-term data collection to document both short-term and long-term dynamics in response to these treatments and a variable climate. The KNZ program is built around a long-term database on ecological patterns and processes derived from a fully replicated watershed-level experimental design, in place since 1977 with some modifications to accommodate new long-term studies initiated in LTER V and VI (e.g., the watershed-level "Fire Reversal" and Season of Fire experiments, the Riparian Woody Vegetation Removal experiment, the Patch-Burn Grazing Studies, and others). This unique experimental design includes replicate watersheds subject to different fire and grazing treatments, as well as a number of long-term plot-level experiments which allow us to address the mechanisms underlying responses to various fire and grazing regimes.

In addition to fire and grazing, climatic variability, climate extremes and directional climate change are key drivers of grassland dynamics, and important focal areas for KNZ activities. The effects of climate are being addressed by long-term studies encompassing the natural climatic variability, and possible directional changes, characteristic of this region, as well as manipulations of water availability and temperature in ongoing field experiments in both terrestrial (*i.e.*, the Irrigation Transect Study and the Rainfall Manipulation Plots (RaMPs) Experiment) and aquatic (i.e., Experimental Stream Studies) habitats. Within core LTER watersheds, permanent sampling transects are replicated at various topographic positions (n=4/topo. position/watershed), where ANPP, plant species composition, plant and consumer populations, soil properties, and key above- and belowground processes are measured. The collection of diverse data from common sampling locations facilitates integration among our research groups. In total, the Konza LTER Program incorporates explicit study of the major factors influencing mesic grasslands in a long-term experimental setting. It is a rigorous ecological research program designed to elucidate patterns and processes inherently important in grasslands, and address the potential impacts of global change in these ecosystems. Towards this end, we currently maintain >90 long-term datasets in association with long-term experiments ongoing as part of this program, and many more research activities of planned shorter duration.

We are in the 5th year (2012-2013) of our most recent LTER grant (LTER VI, 2008-2014), and we continue to address a broad spectrum of fundamental ecological questions with an emphasis on understanding the consequences of global change for ecological dynamics in grasslands, a theme relevant to understanding, managing and conserving grasslands worldwide. Our activities focus on long-term responses to facets of global change most relevant to grasslands and grassland streams – *changes in land-use* (altered fire and grazing regimes, grassland restoration) and *land-cover* (species changes, particularly increases in woody plant cover); *climate change and altered hydrology* in both terrestrial and aquatic environments; and *altered nutrient cycles* (enhanced N deposition) – and we couple long-term observations with manipulative studies to provide mechanistic explanations for these responses. Our research also addresses biotic interactions (competition, mutualism, predation, herbivory) in grasslands, in order to provide insight into a broad range of general ecological phenomena. In total, our goals for LTER VI are to:

1. maintain and expand the strong core LTER experiments and data sets on fire, grazing and climatic variability begun over 25 years ago, with the goal of refining our understanding of the major abiotic and biotic factors determining grassland structure and function;

2. continue developing a mechanistic and predictive understanding of grassland dynamics and trajectories of change in response to global change drivers, using ongoing and new long-term experiments and datasets coupled with shorter-term supporting studies;

3. support and promote new synthesis activities based on our LTER results and data from other sites and studies, to use these syntheses to expand the inference of KNZ results, and to develop and test ecological theory;

4. continue education and outreach activities to make our results relevant to society.

Consistent with our goals as a long-term ecological research program, many of the long-term experiments and datasets initiated in previous LTER grants are being continued throughout the current funding period, while several new

experiments and datasets were, and are, being initiated, as detailed in the original KNZ LTER VI proposal. The value of these long-term experiments and datasets continues to increase with time. In addition, results from these long-term studies have new relevance as we move towards evaluating the ecological impacts of a suite of global change phenomena occurring at the Konza LTER site and in grasslands worldwide. Below we highlight a few selected activities and findings from our most recent funding period.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

We continued the watershed-level fire experiments, and associated data collection efforts, that have been central to our "core" LTER studies since the initiation of the Konza LTER program. This includes watershed-level manipulations of fire frequencies (1, 2, 4 and 20 year fire return intervals) and seasonal timing of fires (spring, summer, autumn and winter), and experiments to assess the potential for changes in fire treatments to reverse trajectories of land-cover change (the Fire Reversal experiment). We also continued to assess the interactive effects of ungulate grazers and fire on tallgrass prairie dynamics, using data from two large-scale grazing studies. Our studies of native ungulate grazers includes 10 watersheds with different fire frequencies (1, 2, 4 and 20 year fire return intervals) grazed by a bison heard managed to remove approx. 25% of our mean annual ANPP. This watershed-scale fire-grazing experiment is also being used in a related NSF project (Joern, Biggs and others, 2010-2013) to assess N-driven feedbacks affecting the landscape-level distributions and foraging activity of bison and the resulting effects on spatiotemporal heterogeneity and herbivorous insects. As part of the LTER VI grant, we also initiated studies of ecological responses to alternative cattle grazing practices (traditional season-long grazing on annually burned grasslands and an alternative patch-burn grazing system designed to enhance spatial and temporal heterogeneity to achieve conservation goals). These whole watershed fire and grazing treatments are focal areas for soil, water, plant and consumer sampling, remote sensing and GIS observations, flux tower and associated sensor network measurements, and groundwater and stream monitoring networks. Many of our core LTER datasets are based on documenting long-term responses to these watershed-level manipulations. In addition, the template of watersheds with varied fire-grazing treatments and varied plant and animal communities provides a unique platform for many smaller-scale experiments, including nutrient manipulations, grazing exclosures, rainfall manipulations, species removals, etc. In addition, these watershed treatments continue to be used by numerous visiting researchers. For example, in 2013 watersheds with different fire regimes were used for studies of genetic plant population structure and community invasibility by graduate students from Yale (Melinda Smith, PI), studies of methanotrophic bacterial communities by researchers from Colorado State University (Joe von Fischer, PI), studies of C cycling and decomposer communities by researchers from Colorado State University (Francesca Cotfuro, PI), and for studies of climate change by graduate students from Colorado State University and the University of New Mexico.

In addition to the watershed treatments, we maintained or expanded several other key LTER projects. We continued several ongoing grassland restoration experiments, including the newly-initiated Restoration Chronosequence experiment as specified in our LTER VI proposal. In addition, we identified a series of 8 independent restored grassland sites on, and in the vicinity, of KNZ which were the focus of a 2013 REU project and part of the MS project of an SIU graduate student. We also continued the Riparian Woody Plant Removal experiment initiated along 4.8 km of stream in 2011, and expanded a new LTER VI project to document land-use and land-cover impacts on stream geomorphology. We provide greater detail about these projects and other selected research activities in the attached pdf.

Information management, and enhancing access to data and metadata, is a priority for the KNZ LTER program. Major IM activities in 2013 included making all KNZ data PASTA-compliant with focus on EML 2.1 integration, updating all existing KNZ data sets, and expanding the KNZ data catalog with new LTER datasets and associated metadata. These activities were led by Adam Skibbe (KNZ IM) and Carol Gadbury (LTER Program Assistant and Archivist), with assistance from LTER student employees Severin Mortensen, Jamie Ernst, Henry Meadors, and John Zuercher (data enterers), Aaron Voth (programmer) and Thomas Kuhn (GIS assistant). We devoted significant core and supplemental LTER resources toward reviewing, and revising as necessary, KNZ metadata to meet new target metrics set forth by the LTER IMC. This was a significant undertaking, as many specific metadata requirements for EML 2.1 were not included in previous EML versions, and some KNZ datasets did not yet have EML-based metadata. Part of the process of making our IMS NIS-compatible included a variety of automation workflows to ensure that KNZ data and metadata are as up to date, and as clean as possible. We instituted a series of manual (human) checks and automated scripts to help with this. We maintain an open data access policy, and our on-line data are available to outside investigators without restriction. We continue to offer data downloads via a variety of search and browse options in the “Data” section of our website, as both ASCII text files and SQL Server download with a query option. As a result of the activities mentioned above, the majority of our data products (approximately 80%) are now also available via the NIS data portal (a current total of 70 datasets, many of which include multiple related data packages). The KNZ IMS continues to include an up-to-date list of all KNZ LTER-supported and LTER-related publications including journal articles, conference proceedings, books and book chapters, theses and dissertations, and electronic publications. The list is searchable by key words, author name, and date. We link personnel with publications through a dynamic connection with our SQL Server database, making it easy for users to find specific personnel information and publications.

Supplemental LTER funds targeted for IM activities in 2013 were used for support personnel related to improving data discovery and accesibility. Severin Mortensen was supported as a part-time IM assistant to update and expand KNZ metadata and create and update EML files. Thomas Kuhn was hired as a GIS assistant to increase KNZ geospatial data holdings. We expanded our geospatial data from approx. 25 datasets to its current status of 173 geospatial data layers and associated metadata. Mr. Kuhn also created an online portal for accessing GIS data and metadata, including interactive mapping capabilities built on the Google Earth API: http://www.konza.ksu.edu/knz/map/index.html. Our LTER supplement also supported Aaron Voth (web developer and programmer) hired to expand and enhance the KNZ web site and portals. This is an ongoing process, the website improvements will be both small and large in scope ranging from small fixes to value-added interactive data exploration. Mr. Skibbe was elected to the IM Executive Committee (IMExec) and continued to collaborate with other LTER IMs managers in a variety of network-level activities. He is participating in research projects with individuals from other sites, and continued to work on the development of GeoNIS, a value-added geodatabase for the geospatial data components of the NIS. With supporting funds from the LNO, Skibbe attended a workshop in early 2013 to continue development of the GeoNIS framework, and to work with a programmer dedicated to the GeioNIS project.

The attached pdf includes additional activities not included here due to space constraints. Those activities include educational activities (graduate student training, REUs, SLTER, etc.), cross-site and network-level activities, and outreach and broader impact activities.

Specific Objectives: 1. Continue watershed-level treatments fire and grazing and associated LTER data

collection on “core” LTER watersheds. The site-based experimental design at the KNZ LTER site includes watersheds that are assigned different fire treatments (1, 2, 4 and 20-yr fire return intervals; spring, summer, winter fall seasons of burn; reversal of historic fire treatments) and different grazing treatments (no large ungulate grazers; grazed by native ungulates (bison); grazed by cattle). Continue to collect, process and analyze LTER data on a suite of ecological variables from permanent sampling locations on these watersheds to assess short- and long-term responses the fire and grazing treatments, to interannual climatic variability, and to document ongoing changes in land-cover (e.g., woody plant encroachment, species turnover, species invasions) and other ecological properties and processes.

2. Continue analyses of the dynamics of woody plant expansion into grasslands, using long-term data from KNZ and other sites to assess thresholds and critical transitions. Couple this with short-term mechanistic studies to identify potential feedbacks that could lead to alternative stable states of grassland and woodland. Complete analysis of data and manuscript from Fire Reversal Experiment.

3. Continue Riparian Woody Plant Removal study to assess the impact of woody plant expansion on grassland stream ecosystems and linkages between terrestrial and stream ecosystems. Add additional measurements on N cycling responses in riparian and stream habitats.

4. Complete the first three-year segment of the Patch-Burn Grazing Study (one complete rotation of fire across the three subwatershed units). Continue collection of data on animal performance, habitat heterogeneity, plant community dynamics and consumer responses.

5. Continue short- and long-term experiments focused on grassland responses to climatic variability and climate change. These experiments include the Irrigation Transect study (1991-present), the Rainfall Manipulation Plots (RaMPs) study (1997-present), and several shorter-term studies being done graduate students. Initiate new measurements to assess above- and below-ground plant and soil responses in the Irrigation Transect Study. Assist with establishment of a new climate change study site funded by a Macrosystems Biology grant (the Extreme Drought in Grasslands Experiment, EDGE).

6. Continue experiments to assess responses to nutrient enrichment in both terrestrial and aquatic environments. Terrestrial nutrient enrichment experiments include the Belowground Plot Experiment (1986-present), the P-Plot Experiment (2002-present), and the NutNet Experiment (2007-present). Aquatic experiments include KNZ’s participation in the Macrosystem’s Biology SCALER project, and graduate student projects using the Experimental Stream facility at KNZ.

7. Continue to implement the Restoration Chronosequence Experiment. Two of the five stages of this experiment have been planted and sampling will continue this year, with the next stage scheduled for planting in 2014. Continue sampling and data analysis of other KNZ restoration experiments as detailed in LTER VI proposal.

8. Continue to update KNZ LTER database to meet requirements for the LTER Network Information System. Provide up-to-date, accurate LTER data to KNZ investigators and to the broader scientific community as quickly and efficiently as possible.

9. Continue KNZ education and outreach activities to achieve our broader impact goals. Continue and expand SLTER on-site science activities and enlist new classes and students. Provide opportunities for undergraduate research experiences and continue to support graduate student research and training. Contribute LTER data to

address relevant environmental issues (e.g., prescribed fires and air quality, land-use and water quality). Expand science and art interactions as a novel way of increasing awareness of and interest in grassland ecology and grassland conservation.

Significant Results:

Our “core” LTER datasets, collected on watersheds with contrasting fire and grazing treatments, continued to provide unique insights into how fire and grazing independently and interactively affect ecological properties and processes in grasslands. KNZ LTER data on plant productivity, soil processes, plant community structure, consumer population dynamics, and related data sets were also used for both site-specific and cross-site analyses (e.g., scaling and modeling activities, response to regional climate gradients or local climatic variability, etc.). Here we highlight just a few recent results, with additional details about these and other studies provided in the attached pdf file and in our publication and products list.

Land-use conversion and associated changes in land-cover are major threats to grasslands globally. KNZ watersheds with contrasting fire and grazing regimes, in place for over 30 years, continue to serve as a laboratory for exploring the dynamics, causes and consequences of woody plant encroachment into grasslands. In past KNZ annual reports, we highlighted studies that documented the temporal dynamics of woody plant expansion into watersheds with varying fire histories and grazing treatments, the physiological and demographic mechanisms than contribute to woody invader success, and the changes in ecosystem processes that accompany woody encroachment. The spatial and temporal dynamics of grassland-shrubland conversion coupled with demographic and physiological feedbacks that maintain the dominance of woody plants are consistent with a transition to an alternative, and potentially novel, stable state. To address this phenomenon and identify ‘early warning signs’ that could permit forecasting of state shifts, we quantified the temporal dynamics of community change in watersheds undergoing woody plant expansion at KNZ, and used long-term datasets from KNZ and other grasslands to improve our ability to predict and assess the consequences of such state transitions. A meta-analysis of 29 studies from 13 different grassland/savanna communities in North America (including KNZ) revealed declines in species richness with woody plant encroachment (average decline = 45%). Loss of species was greatest in communities with high precipitation ($r2 = 0.81$) and where encroachment led to greater changes in ANPP ($r2 = 0.69$) (Ratajczak et al. 2012). This relationship between species richness and ANPP is consistent with the theoretical expectation of trade-offs between richness and productivity in herbaceous communities. An additional paper documenting these abrupt transitions and highlighting evidence for alternative attractors, critical thresholds and critical transitions is currently in revision for Ecology, and another is in review.

To better understand how contrasting fire regimes influences soil moisture in grasslands, Craine and Nippert (2013) analyzed 28 years of soil moisture data from two KNZ watersheds that differ in long-term fire frequency. Cessation of prescribed burning initially led to wetter soils as litter accumulated and both transpiration and evaporation were suppressed. However, in the long-term, lack of fire led to changes in vegetation structure (increased woody vegetation) and drier soils, especially at depths greater than 75 cm. Reductions in deep soil water are consistent with increased woody cover and greater utilization of deep soil water under low fire frequency (Nippert et al. 2012, Ratajczak et al. 2011). These results provide an important potential linkage between terrestrial land-cover changes and grassland stream hydrology and ecology, and are highly relevant to our riparian vegetation removal experiment.

KNZ co-PI Joern and PhD student E.J. Raynor are assessing fine-scale foraging behavior by bison with respect to landscape location, season, and forage quality. At

the smallest scale, bite rate declined with increasing grass height in biennially burned watersheds during summer, whereas no significant relationships were observed in other season by treatment combinations. In addition, bite rate declined with increasing biomass during spring and summer in newly burned watersheds with a history of fire exclusion, consistent with predicted effects of infrequent fires on N dynamics (i.e., Transient Maximum Hypothesis). At the patch scale, foliar %-N in areas grazed by bison was 20% higher than areas not selected by bison. By fitting forage intake rate to available plant biomass using a non-linear Michaelis-Menten function, we identified seasonal changes in rates of forage intake related to standing plant biomass. This study provides evidence that the forage intake rate of bison feeding in tallgrass prairie is restricted by ingestion rate, and suggests that bison adjust foraging behaviors in relation to seasonal variations in vegetation quality (i.e., N content) and plant abundance.

KNZ studies are also assessing the potential for alternative fire and grazing management practices to maintain greater biodiversity in grasslands by promoting greater heterogeneity within managed grasslands. Patch-burn grazing is generally thought to maintain higher diversity of grassland plants, but this has not been well-documented and the demographic responses of consumers are in need of study. In 2013, we completed one complete 3-year fire cycle to assess the responses of grassland vertebrate and invertebrate populations to patch-burn grazing. Initial results show enhanced species richness of birds in patch-burn pastures that were rested from fire for 1-2 years, but changes in bird abundance were species-specific, highlighting the value of habitat heterogeneity on lands managed for cattle production. In 2013, we started color-banding of territorial birds to estimate annual survival rates. Preliminary results indicate that patch-burn grazing may affect bird densities more than reproductive performance. Initial analyses of grasshopper diversity were also completed for the first 3-year cycle. Densities on control watersheds were significantly greater (about 2x) than those on patch burn watershed, and grasshopper species diversity (H') did not differ significantly among patch-burn vs. control-treatment watersheds. However, grasshopper species composition within individual 'patches' did differ according to the time since the last burn. These results suggest that grasshoppers also respond to differences among 'patches' with different fire treatments within these rotational watersheds.

Long-term KNZ data were used to assess ecological impacts of interannual and intra-annual climatic variability. These papers include analyses of critical climate periods – windows of time when precipitation or temperature have a disproportionate effect on annual productivity or plant reproductive effort (LaPierre et al. 2011, Craine et al. 2012, 2013) and a cross-site analysis of relationships between interannual climatic variability and plant species richness and turnover (Cleland et al. 2013). Collectively these studies illustrate the value of long-term (in many cases > 25 yrs) data for forecasting ecological responses to future environmental conditions and highlight the critical nature of rainfall timing (both within and between years) as a driver of productivity and reproductive effort in mesic grasslands.

Dr. Lydia Zeglin, who will soon be joining KSU and the KNZ program, used a long-term climate manipulation experiment at KNZ to assess how climate change impacts microbially-mediated C cycling functions at different levels of expression and regulation. Zeglin et al. (2013) concurrently evaluated soil microbial and enzymatic activities and microbial community composition. They found that drier soil conditions associated with altered rainfall timing led to lower CO2 loss via respiration, lower potential for soil organic matter (SOM) decomposition via enzyme activity, and enhanced potential for SOM accumulation via microbial growth.

Key outcomes or See significant results and impact sections.

Other achievements:

*** What opportunities for training and professional development has the project provided?**

Graduate student training continues to be an important component of our LTER program. During this funding period, we provided stipends and/or other support (computer, laboratory, field vehicles, etc.) for >20 graduate students. In addition to KSU students, the Konza Prairie site continues to be used by graduate students from a number of other U.S. institutions including in 2012-13: Colorado State University (David Hoover, Kevin Wilcox, Ashley, Shaw, Jenny Song), Cornell University (Rebecca Lohnes), Southern Illinois University (Ryan Klopf, Dan Whiting, Kim Erndt, Jodi Vandermyde), Yale University (Meghan Avolio, Kimberly LaPierre, Beth Forrestel), Oklahoma State University (Ray West, Melinda Williamson), University of Kansas (M Petrie), and the University of New Mexico (Sally Korner), among others.

The Konza LTER program also offers research experiences for a large number of undergraduate students. In 2013, we supported 2 LTER REU students with supplements, and contributed additional support to the KSU/Konza REU site program. Summer 2013 was the 18th year that Konza Prairie and the Division of Biology at K-State have offered a 10-week summer undergraduate research program. Participants in the structured program included 10 students supported by NSF-funded REU Site and Supplements, and 7 students supported by a related NSF-funded Undergraduate Research Mentoring (URM) program, being co-led by LTER investigator Ari Jumpponen. While research at the KNZ site is not mandatory for URM students, many URM students do conduct a portion of their research there. Examples of these projects include: distribution of crickets (*Allonemobius socius*, *A*. sp. nov. Tex, and *A. shalontaki*) to identify areas of sympatry; species richness, diversity, and community composition of mycorrhizal fungi inhabiting native and non-native hosts; and, phenology and morphological variability of *Andropogon gerardii*. The KSU URM program also integrates with the Konza Prairie LTER site REU program. Among the examples of these integration activities are: URM/REU mentor seminars to the REU and URM students; URM student presentations in REU grand finale symposium; shared data blitz in the Ecological Genomics forum; concurrent ethics training; and, participation in Konza Prairie LTER workshop.

Formal educational activities at the K-12 level began with the initiation of the Konza Environmental Education Program (KEEP) in 1996, and were greatly expanded with the initiation of the Konza Prairie Schoolyard LTER (SLTER) in 1998. The Konza Prairie Schoolyard LTER (SLTER) program is now entering its 15th year as a science education program for K-12 teachers and their students, built around the successful Konza Prairie LTER program. Our SLTER program continues to prosper with input from Konza LTER PIs and Kansas K-12 educators. The Konza Prairie SLTER program aims to educate students about ecology and global change, with emphasis on regional grasslands, by engaging students and teachers in realistic and relevant science-based activities focused on long-term data collection at our LTER site. These activities were designed to give students an understanding of ecology, provide them the opportunity to collect and interpret their own data, and integrate their data into our long-term SLTER databases via the Internet (keep.konza.ksu.edu). By sharing knowledge generated through long-term data collections we give teachers tools for connecting children to locally and regionally important ecosystems.

The KNZ SLTER program continues to grow with annual Summer Teacher's Workshops. These workshops serve to initiate new teachers into the Konza SLTER program. Teachers experience all of the science activities first-hand and are then assisted in the development of new curriculum that incorporates a class' visit to the Konza Prairie. The workshops are the single strongest tool we have to sell new teachers on the science education available to their students.

The KNZ SLTER program continues to grow in terms of participating teachers and numbers of students reached. In 2012-13, a total of 1,055 students from 20 schools participated in 35 hands-on activities at Konza Prairie. With continued SLTER support in 2013-14, we anticipate involving ~1000 additional students in activities at Konza. Data collected from SLTER activities will continue to be incorporated into SLTER databases. In this way, individual class data can be accessed along with the long-term databases through the Internet and manipulated in the classroom to give students a better understanding of the process of science and the value of long-term ecological information.

*** How have the results been disseminated to communities of interest?**

Konza LTER results are disseminated to the scientific community via publications in the peer-reviewed literature, through presentations at professional meetings and workshops, through seminars by KNZ scientists and students and via the KNZ and LNO LTER web sites. In addition, KNZ scientists have participated in a broad range of activities that go beyond the scientific community. For example, KNZ data and findings are used in a number of undergraduate and graduate ecology courses at Kansas State University, the University of Arizona, Colorado State University, and Ohio University, among

others. In addition, KNZ findings are increasingly utilized in undergraduate ecology texts and supplementary teaching materials. For example, KNZ long-term studies are used to demonstrate the role of fire and grazing in grasslands in 'General Ecology, 2nd edition' by D.T. Krohne, and as an example of the importance of long-term research in the 'Ecology' text by Cain et al. A recent KNZ study by Collins et al. is featured as a 'case study' in the on-line supplement to 'Ecology. Theory and Applications. 3rd edition' by P. Stiling. KNZ studies on top-down regulation of plant community structure are featured in an introductory undergraduate biology text ('Life. The Science of Biology. 7th edition' by Purves, Sadava, Orians and Heller) and KNZ data and findings are highlighted in several upper-level and graduate texts including 'Freshwater Ecology' (W.K. Dodds), 'The Ecology of Plants' (Gurevitch, Scheiner and Fox), and 'Biogeochemistry. An Analysis of Global Change' (W.H. Schlesinger). KNZ graduate students and PIs have also co-authored several educational publications, based on LTER data, for the peer-reviewed ESA-supported Teaching Issues and Experiments in Ecology (TIEE) and other education-based outlets.

*** What do you plan to do during the next reporting period to accomplish the goals?**

We will continue collection of "core" LTER data associated with our long-term fire and grazing treatments on the KNZ watersheds. These data are used by both KNZ scientists and students, and by resesrchers from a number of other institutions for both site-specific and various cross-site and synthetic analyses.

We will continue to collect and analyze data associated with new experiments that were initiated in the KNZ LTER VI grant. Specifically, we will continue(1) the patch-burn grazing study (the second 3-year rotation of fire treatments will take place in 2014-2016), (2) the restoration chronosequence study (in 2014 we will initiate the third of five planned blocks that are required to complete the entire restoration chronosequence experiment), and (3) the riparian woody plant removal experiment (will continue to quantify response variables on treated and control streams).

Our current Information Manager (Adam Skibbe) recently accepted a GIS-related position at the University of Iowa. We have completed a search for a new IM, who will be joining the KNZ program in December of 2013. Her name is Yang Xia, and she has extensive LTER experience. She completed her MS research in plant ecology at the Jornada LTER site, worked as a field and data assistant at the Sevilleta site, and has been under contract with the LNO as Informaion Manager for the past 5 years. Yang is very familiar with EML and the requirements of PASTA and the NIS, and will be working with us to continue the upgrades and improvements initiated by Mr. Skibbe. In the upcoming year, we will add new data sets to the KNZ database, as needed, and will continue to update existing data sets with new data as soon as it meets quality control standards and ensure compatibility with the LTER Network Information System. We plan several organizational changes and upgrades to the KNZ website in the coming year, which should make it easier to search for and find specific information and data.

There are no other major change or deviations from our original LTER VI proposal anticipated for the coming year.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
LTER Activities 2013.pdf	Detailed information regarding KNZ LTER activities in 2012-13	John Blair	10/22/2013
LTER Findings 2013.pdf	Detailed report of recent KNZ LTER findings for 2012-13	John Blair	10/22/2013

Products

Journals

Avolio, Meghan L.; Beaulieu, Jeremy M.; Lo, Eugenia Y. Y.; Smith, Melinda D. (2012). Measuring genetic diversity in ecological studies. *PLANT ECOLOGY*. 213 (7), 1105-1115.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Bach, Elizabeth M.; Baer, Sara G.; Six, Johan (2012). Plant and soil responses to high and low diversity grassland restoration practices. *ENVIRONMENTAL MANAGEMENT*. 49 (2), 412-424.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Carter, Daniel L.; VanderWeide, Benjamin L.; Blair, John M. (2012). Drought-mediated stem and below-ground bud dynamics in restored grasslands. *APPLIED VEGETATION SCIENCE*. 15 (4), 470-478.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Carter, Daniel L.; Blair, John M. (2012). Recovery of Native Plant Community Characteristics on a Chronosequence of Restored Prairies Seeded into Pastures in West-Central Iowa. *RESTORATION ECOLOGY*. 20 (2), 170-179.

Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

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Killian, P.D. *Mechanisms driving woody encroachment in the tallgrass prairie: an analysis of fire behavior and physiological integration*. (2012). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Nukala, L.A. *An iPhone application of Konza Prairie LTER*. (2012). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Ocheltree, T.W. *Growth and survival during drought: The link between hydraulic architecture and drought tolerance in grasses*. (2012). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Olstad, T.A. *Zen of the Plains: discovering space, place, and self*. (2012). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Sousa, B.F. *Ecology of mating patterns and sexual selection in dickcissels breeding in managed prairie*. (2012). University of Kentucky. Lexington, KY.

Acknowledgment of Federal Support = Yes

O'Keefe, K. *Influences of local adaptation and genome size on Panicum virgatum (switchgrass) responses to variable precipitation timing*. (2012). St. Joseph's University. Philadelphia, PA.

Acknowledgment of Federal Support = Yes

Tomeo, N.J. *A mycorrhizal community is unresponsive to simulated future precipitation variability*. (2012). St. Joseph's University. Philadelphia, PA.

Acknowledgment of Federal Support = Yes

Vandermyde, J. *Macroinvertebrate responses to removal of riparian woody vegetation along tallgrass prairie streams*. (2013). Southern Illinois University. Carbondale, IL.

Acknowledgment of Federal Support = Yes

West, R. *Bud bank demography: Density of native grass meristems as a predictor of rangeland invasibility*. (2012). Oklahoma State University. Stillwater, OK.

Acknowledgment of Federal Support = Yes

Carter, D. *Grassland restoration in a changing world: consequences of practices and variable environments*. (2013). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Carson, M. *Responses to long-term fertilization and burning: impacts on nutrient dynamics and microbial composition in a*

tallgrass prairie. (2013). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Vanderweide, B. *Grazing and drought in tallgrass prairie: the role of belowground bud banks in vegetation dynamics*. (2013). Kansas State University. Manhattan, KS.

Acknowledgment of Federal Support = Yes

Conference Papers and Presentations

Other Publications

Baer, S.G. (2013). *Restoration Ecology*. In Oxford Bibliographies in Ecology. Edited by D. Gibson. New York: Oxford University Press. http://www.oxfordbibliographies.com/.

Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Technologies or Techniques

Nothing to report.

Patents

Nothing to report.

Inventions

Nothing to report.

Licenses

Nothing to report.

Websites

Title:	Konza Prairie LTER web site
URL:	http://www.konza.ksu.edu/knz/
Description:	This is the main web site for the dissemination of information about the Konza Prairie LTER Program. The web site includes information about the KPBS site, the KNZ research program, copies of key documents, access to the KNZ LTER database, and a list of KNZ publications and products.

Other Products

Product Type:	Databases
Description:	The KNZ LTER database is accessible via the Konza Prairie LTER web site, or via the LTER network database.
Other:	Physical Collections
Product Type:	The Konza Prairie LTER program maintains physical collections of soils, plant tissue and water samples, which are cataloged and archived for future use by LTER scientists or by the broader scientific community. Samples are made available by request to LTER scientists responsible for specific sample types.
Description:	
Other:	Software or Netware
Product Type:	online portal for accessing GIS data and metadata, including interactive mapping capabilities built on the Google Earth API: http://www.konza.ksu.edu/knz/map/index.html.
Description:	

Other:

Participants

Research Experience for Undergraduates (REU) funding

How many REU applications were received during this reporting period? 6

How many REU applicants were selected and agreed to participate during this reporting period? 2

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Patrick Harris	Graduate Student (research assistant)	5
John Zuercher	Undergraduate Student	3
Gregory Zolnerowich	Co-Investigator	1
Gail Wilson	Co-Investigator	1
Nick Wilson	Undergraduate Student	1
Kevin Wilcox	Graduate Student (research assistant)	12
Eric Wiens	Undergraduate Student	1
Nick Wiber	Undergraduate Student	2
Matt Whiles	Co-Investigator	2
Ray West	Graduate Student (research assistant)	12
Nathan Wendt	Undergraduate Student	2
Ellen Welti	Graduate Student (research assistant)	12
Aaron Voth	Technician	2
Bram Verheijen	Graduate Student (research assistant)	12
Alison Veach	Graduate Student (research assistant)	12
Ben VanderWeide	Graduate Student (research assistant)	12
Jodi Vandermyde	Graduate Student (research assistant)	12
Gene Towne	Staff Scientist (doctoral level)	12
Jeff Taylor	Non-Student Research Assistant	12
Nicole Stanton	Graduate Student (research assistant)	12
Jack Sparks	Other	4

Name	Most Senior Project Role	Nearest Person Month Worked
Jennifer Song	Graduate Student (research assistant)	12
Melinda Smith	Co-Investigator	2
Adam Skibbe	Other Professional	12
Adam Siders	Research Experience for Undergraduates (REU) Participant	2
Drew Scott	Graduate Student (research assistant)	5
Brett Sandercock	Co-Investigator	1
Grant Samms	Undergraduate Student	1
Steven Rosenzweig	Research Experience for Undergraduates (REU) Participant	2
Susan Rolfsmeier	Graduate Student (research assistant)	12
Brianna Roberts	Graduate Student (research assistant)	12
Andrew Ricketts	Graduate Student (research assistant)	12
Charles Rice	Co-Investigator	1
Edward Raynor	Graduate Student (research assistant)	12
Zak Ratajczak	Graduate Student (research assistant)	12
Rosemary Ramundo	Non-Student Research Assistant	12
Kevin Price	Co-Investigator	1
Jacquiline Ott	Graduate Student (research assistant)	12
KC Olson	Co-Investigator	1
Patrick O'Neal	Non-Student Research Assistant	12
Hunter Nunnenkamp	Undergraduate Student	1
Eric Noel	Undergraduate Student	1
Jesse B Nippert	Co PD/PI	2

Name	Most Senior Project Role	Nearest Person Month Worked
Severin Mortensen	Undergraduate Student	3
Nick Meyer	Undergraduate Student	1
Henry Meadors	Undergraduate Student	3
Kendra McLauchlan	Co-Investigator	1
Robert McKane	Co-Investigator	1
Erika Martin	Graduate Student (research assistant)	12
George Manning	Graduate Student (research assistant)	5
Willow Malone	Research Experience for Undergraduates (REU) Participant	2
Gwendolyn Macpherson	Co-Investigator	1
Nick Lowman	Undergraduate Student	2
Huan Liu	Graduate Student (research assistant)	12
Danelle Larson	Graduate Student (research assistant)	12
Kimberly LaPierre	Graduate Student (research assistant)	12
Thomas Kuhn	Technician	12
Amanda Kuhl	Non-Student Research Assistant	12
James Koelliker	Co-Investigator	1
Alan Knapp	Co-Investigator	2
Sally Kittrell	Graduate Student (research assistant)	12
Gracie Orozco	Undergraduate Student	2
Benjamin Ketter	Research Experience for Undergraduates (REU) Participant	2
Glennis Kaufman	Staff Scientist (doctoral level)	1
Donald Kaufman	Co-Investigator	1

Name	Most Senior Project Role	Nearest Person Month Worked
Michael Kaiser	Research Experience for Undergraduates (REU) Participant	2
John Brandt	Research Experience for Undergraduates (REU) Participant	2
Alessandro Bartolo	Research Experience for Undergraduates (REU) Participant	2
Ari Jumponnen	Co-Investigator	1
Loretta Johnson	Co-Investigator	1
Anthony Joern	Co PD/PI	2
William Jensen	Co-Investigator	1
Karen Jackson	Graduate Student (research assistant)	12
Stacy Hutchinson	Co-Investigator	1
AJ Horton	Graduate Student (research assistant)	12
Eva Horne	Co-Investigator	1
David Hoover	Graduate Student (research assistant)	12
Luc Heimbach	Undergraduate Student	4
Jill Haukos	Other Professional	12
David C Hartnett	Co PD/PI	2
Grady Harris	Undergraduate Student	6
John Harrington Jr.	Co-Investigator	2
Bart Grudzinski	Graduate Student (research assistant)	12
Mitchell Greer	Graduate Student (research assistant)	12
Douglas Goodin	Co-Investigator	1
Jesus Gomez	Graduate Student (research assistant)	12
Keith Gido	Co-Investigator	1

Name	Most Senior Project Role	Nearest Person Month Worked
Karen Garrett	Co-Investigator	1
Carol Gadbury	Other	6
Elisabeth Forrestel	Graduate Student (research assistant)	12
Carolyn Ferguson	Co-Investigator	1
Phillip Fay	Co-Investigator	1
Jan Evans	Other	1
Jamie Ernst	Undergraduate Student	2
Kim Erndt	Graduate Student (research assistant)	12
Walter K Dodds	Co PD/PI	2
Jeffrey Delaroy	Undergraduate Student	2
Melinda Daniels	Co-Investigator	2
Joseph Craine	Co-Investigator	1
Katie Costigan	Graduate Student (research assistant)	6
Kevin Cook	Undergraduate Student	4
Scott Collins	Co-Investigator	1
Dan Carter	Graduate Student (research assistant)	1
Michael Carson	Graduate Student (research assistant)	12
John Briggs	Co-Investigator	2
John M Blair	PD/PI	4
Sara Baer	Co-Investigator	2
Meghan Avolio	Postdoctoral (scholar, fellow or other postdoctoral position)	4
Taylor Atwell	Undergraduate Student	4
Nan An	Graduate Student (research assistant)	12

What other organizations have been involved as partners?

Name	Location
Colorado State University	Fort Collins, CO
Kansas State of	Topeka, Kansas
National Oceanic and Atmospheric Administration (NOAA)	USA
Oklahoma State University	Stillwater, OK
Southern Illinois University at Carbondale	Carbondale, IL
The Nature Conservancy	USA
U S Department of Energy	USA
US EPA	USA
USGS	USA
University of Kansas	Lawrence, KS

Have other collaborators or contacts been involved? Y

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The Konza Prairie LTER Program is a comprehensive, interdisciplinary research program designed to contribute to synthetic activities and conceptual and theoretical advances in ecology, and to further an understanding of ecological processes in mesic grasslands. Examples of specific recent contributions to the discipline of ecology are provided in the attached 'Konza LTER Findings' file. Here, we summarize in more general terms the contributions of the Konza LTER program to the advancement of ecology. Konza LTER scientific findings continue to be published in a broad range of high quality journals. In the 2012-2013 period, the KNZ program produced or contributed to 113 publications: 92 refereed journal articles (including 18 currently in press), 4 book chapters, and 16 dissertations and theses. These publications cover topics ranging from the ecophysiology of individual organisms to regional patterns of productivity to consequences of global change in grasslands. Konza LTER scientists continue to publish articles in both disciplinarily focused and more general high impact journals (e.g., Nature, Science, PNAS, BioScience), reflecting significant contributions to the field of ecology. In addition to site-based science, Konza publications include substantial contributions to multi-site, collaborative ecological research, and the widespread use of Konza LTER data and resources by the broader ecology community. For example, Konza LTER data were used in several recent multi-site or synthetic efforts, such as:

Cleland, E.E., S.L. Collins, T.L. Dickson, E.C. Farrer, K.L. Gross, L.A. Gherardi, L.M. Hallett, R.J. Hobbs, J.S. Hsu, K.N. Suding, and L. Turnbull. (*In Press*). Sensitivity of grassland plant community composition to spatial vs. temporal variation in precipitation. Ecology.

Craine, J.M., T.W. Ocheltree, J.B. Nippert, E.G. Towne, A.M. Skibbe, S.W. Kembel, and J.E. Fargione. 2013. Global diversity of drought tolerance and grassland climate-change resilience. Nature Climate Change 3: 63-67.

Fraser, L.H., H.A. Henry, C.N. Carlyle, S.R. White, C. Beierkuhnlein, J.F. Cahill Jr., B.B. Casper, E. Cleland, S.L Collins, J.S. Dukes, A.K. Knapp, E. Lind, R. Long, Y. Luo, P.B. Reich, M.D. Smith, M. Sternberg, R. Turkington. 2013. Coordinated Distributed Experiments: an emerging tool for testing global hypotheses in ecology and environmental science. Frontiers

in Ecology and the Environment 11: 147-155.

Dodds, W.K., C.T. Robinson, E.E. Gaiser, G.J.A. Hansen, H. Powell, J.M. Smith, N.B. Morse, S.L. Johnson, S.V. Gregory, T. Bell, T.K. Kratz, and W.H. McDowell. 2012. Surprises and insights from long-term aquatic datasets and experiments. BioScience 62: 709-721.

Gibson, D.J., A.J. Alstadt, S.G. Baer, and M. Geisler. 2012. Effects of foundation species genotypic diversity on subordinate species richness in an assembling community. Oikos 121: 496-507.

Gough, L., K.L. Gross, E.E. Cleland, C.M. Clark, S.L. Collins, J.E. Fargione, S.C. Pennings, and K.N. Suding. 2012. Incorporating clonal growth form clarifies the role of plant height in response to nitrogen addition. Oecologia 169: 1053-1062.

Jaffé, R., Y. Yamashita, N. Maie, W.T. Cooper, T. Dittmar, W.K. Dodds, J.B. Jones, T. Myoshi, J.R. Ortiz-Zayas, D.C. Podgorski, and A. Watanabe. 2012. Dissolved organic matter in headwater streams: compositional variability across climatic regions of North America. Geochimica et Cosmochimica Acta 94: 95-108.

Knapp, A.K., D.L. Hoover, J.M. Blair, G. Buis, D.E. Burkepile, A. Chamberlain , S.L. Collins, R.W.S. Fynn, K.P. Kirkman, M.D. Smith, D. Blake, N. Govender , P. O'Neal, T. Schreck, and A. Zinn. 2012. A test of two mechanisms proposed to optimize grassland aboveground primary productivity in response to grazing. Journal of Plant Ecology 5: 357-365.

Knapp, A.K., M.D. Smith, S.E. Hobbie, S.L. Collins, T.J. Fahey, G.J.A. Hansen, D.A. Landis, K.J. La Pierre, J.M. Melillo, T.R. Seastedt, G.R. Shaver, and J.R. Webster. 2012. Past, present, and future roles of long-term experiments in the LTER Network. Bioscience 62: 377-389.

It is noteworthy that Konza LTER studies are contributing not only to a better understanding of mesic grasslands, but also to a variety of broader ecological issues, such as the application of ecological theory to restoration ecology (Carter and Blair, 2012, 2013, Carter et al. 2012, Gibson et al. in press), and assessing the extent and limits of ecological generalities derived from one geographic locale to other regions with different evolutionary histories Koerner and Collins in press, Hartnett et al. 2013).

In conjunction with our increasing focus on global change ecology, we also continued to used Konza LTER studies and data to address critical issues related to global environmental change, including the effects of climate change (Heisler et al. 2008, Heisler et al. in press, Fay et al. 2008, Gerten et al. 2008) and critical land-use and land-cover changes (Reisinger, A.J., J.M. Blair, C.W. Rice and W.K. Dodds. 2013. Ratajczak et al. 2012a,b).

Finally, an important contribution of the Konza LTER program to the advancement of ecology is to provide a unique resource, in the form of the site infrastructure, long-term experiments, and available data that can be used by the general ecological community to address a wide range of ecological questions. Konza Prairie serves as a node in many national networks, including the National Atmospheric Deposition Program (NADP), the EPA Clean Air Standards and Trends Network (CASTNET), NOAA's Climate Reference Network (CERN), and the USGS Hydrologic Benchmark Network. The Konza Prairie site has also been selected as a candidate core site for the developing National Ecological Observatory Network (NEON), and Konza LTER scientists have been active participants in the NEON planning process, and in local and domain-level activities. Konza LTER scientists continue to make significant contributions to international collaborative efforts in ecology. David Hartnett has led student-based research trips to sub-Saharan Africa and is a participant in the 'Sekgwa Project' (U. Botswana and Okavango Research Center) to promote collaborative research and training on the ecology and dynamics of southern African grasslands and savannas. Brett Sandercock is collaborating with scientists in Uruguay on a migratory bird project. KNZ co-PI Nippert is working with colleagues in South Africa to expand his KNZ-based research on the causes and consequences of grassland-woodland transitions. Finally, several Konza PIs (Knapp, Blair, Smith, Collins) are continuing research to Konza LTER studies in a test of ecological generalities in South African grasslands.

What is the impact on other disciplines?

The Konza Prairie LTER program and our core research experiments attract numerous scientists from a broad spectrum of scientific disciplines beyond ecology. For example, a hydrogeochemist from the University of Kansas (Gwen Macpherson) is a long-term collaborator in the Konza Prairie LTER program, and we support ongoing long-term studies of

groundwater chemistry sampled via permanent wells located on Konza Prairie. An atmospheric scientist from the University of Kansas (Nate Brunsell) uses Konza sites to study the effects of surface heterogeneity on land atmosphere interactions, and is employing a Large Aperture Scintillometer (LAS) to measure sensible heat fluxes over longer path lengths that span Konza watersheds with ongoing C flux measurements. This allows comparison with eddy covariance stations and satellite derived estimates of surface energy fluxes. In the past year we collaborated with a soil scientist (Francesca Cotrufo) and her students (Colorado State University) to assess patterns and controls of soil carbon dynamics. Another soil scientist from Cornell (Johannes Leahman) used Konza LTER treatments to assess the impacts of landscape position and contemporary management practices on black C accumulation in soils. A hydrologist from Biological and Agricultural Engineering (Stacy Hutchinson) is collaborator on the 'Irrigation Transect Experiment', and has provided numerous training opportunities for Biological and Agricultural Engineering and Hydrology students. Konza Prairie has also become a research platform for several collaborative teams of ecologists and molecular biologists that are part of the KSU Ecological Genomics Initiative. Many of these interdisciplinary teams are using the Konza LTER site and associated long-term experiments to address questions related to the genetic mechanisms underlying plant and animal responses to environmental constraints. The KNZ LTER patch-burn grazing experiment is being done in collaboration with Dr. KC Olson, a grazing animal nutritionist that is using the experiment to assess the impacts of alternate grassland management practices on animal nutrition and animal health. Other contributions to disciplines outside the traditional realm of ecology include the operation of flux towers at the Konza site, which has provided data used by micrometeorologists, climatologists, remote sensing scientists and modelers. We also collaborate with atmospheric chemists and modelers from the EPA CASTNet program in sampling concentrations of selected airborne particles and using these to model dry deposition rates, and in 2006, two new seismographs were installed on the site to facilitate ongoing geologic research by USGS scientists and their collaborators. We also collaborate with NASA scientists in the maintenance and operation of a Cimel sun photometer at the Konza site.

What is the impact on the development of human resources?

The Konza Prairie LTER VI program makes significant contributions to human resource development in science, engineering and technology.
Our program continued to contribute to the training of undergraduates directly (REU students and others) and indirectly (through the use of Konza LTER data in ecology classes and text books). As documented elsewhere in this report, we also train numerous graduate students, and provide valuable experience in interdisciplinary research and the synthetic use of long-term datasets. In addition to supporting KSU graduate students, the Konza Prairie LTER site is widely utilized by graduate students from other institutions. During the current funding period, the site has been used by graduate students from the University of Kansas, University of New Mexico, University of California - Santa Cruz, Southern Illinois University, Colorado State University, Yale University, and several others. We also hosted field trips for students from many regional colleges and universities, and in the last year we hosted a summer student training field trip organized by Haskell Indian Nations University.

The Konza Environmental Education program, and the Konza Prairie Schoolyard LTER Program, provide formal and informal research
experiences and science education to public groups, children and K-12 teachers, as well as training experience for a graduate student in the
College of Education. Konza LTER research in restoration ecology was used by local high school teachers to develop educational activities
as part of Howard Hughes funded teacher training program. KNZ PI Blair served as consultant and advisor for a local high school teacher (Shane Neel), who is establishing an educational prairie restoration research site as part of his Masters of Education degree program. Finally, the Konza LTER site continues to be used in conjunction with the NSF-funded Girls Researching Our World (GROW) program (www.ksu.edu/grow/), with several KSU scientists and students leading educational activities for 7th and 8th grade girls.

What is the impact on physical resources that form infrastructure?

The Konza LTER program provides a research platform for scientists and students from around the world. The Konza Prairie LTER site (Konza Prairie Biological Station; KPBS) is a 3,487-ha field research site, which includes several buildings devoted to ecological research and education. These physical resources are instrumental in attracting a large number of outside scientists to the site. KPBS facilities include the 4,650 ft.2 Hulbert Center housing a library/conference room, classroom, offices, teaching laboratory, reference herbarium and animal collections, and dormitory-style housing for

15. Two 2-bedroom housing units and a new 4-bedroon cottage expand the accommodation capacity to 32 visiting researchers. The 2,400 ft2 Ecology Laboratory houses 2 analytical laboratories, a soil and root processing lab, a computer room, and researchers' shop. In 2008, the renovation of the ground floor of a historic, 2- story limestone barn at the Konza Prairie Biological Station (KPBS) was completed. The renovated building provides support for the Konza Prairie LTER program and for visiting scientists in the form of a high-quality meeting facility and multi-use space for research, science education, and public outreach programs. Other station buildings include a fire station and shop/maintenance building, storage building for research equipment, and a residence for on-site staff. All KPBS headquarters buildings have T1 Internet connectivity, and the site has wireless data transmission capabilities. Other LTER-related research infrastructure, includes the large 1000 ha bison research area, 98 small (25 m2) grazing exclosures, and 17 km of access roads and 61 km of fireguards separating the experimental watershed treatment units. KPBS maintains several general-purpose vehicles on-site, as well as specialized equipment (tractors, fire trucks, mowers, soil augers, etc.). The headquarters also include a meteorological station, a CIMEL Sun Photometer, and a dry-deposition monitoring facility (CASTNet). A total of 36 experimental stream units are located in the headquarters area. Other field equipment and instrumentation at the site includes three eddy flux towers for quantifying ecosystem-level C flux, four weirs and associated stream gauging equipment, 46 wells for monitoring groundwater levels and chemistry, numerous TDR probes and neutron access tubes for soil water measurements. Additional LTER-supported laboratory facilities are located on the KSU campus, approximately 15 km from KPBS. The majority of LTER laboratory space and analytical equipment are located in Bushnell Hall (Biology), including space and equipment for preparing plant, soil and water samples for analysis (drying ovens, grinders, shaker tables, block digestors, vacuum filtration systems). Two walk-in controlled environment chambers (Conviron PGV 36) are located in Bushnell Hall. Bushnell Hall also houses an extensive collection of prairie plant specimens in the KSU Herbarium. Some specific equipment and facilities are located within other Departments (Agronomy, Biological and Agricultural Engineering, Plant Pathology, Geography), reflecting the interdisciplinary nature of our research. Some major analytical equipment available for LTER research includes: 2 Alpkem autoanalyzers (FlowSolution and RFA500) for liquid samples, a Carlo-Erba 1500 Annual Report: 0823341 Page 84 of 84 automated C/N analyzer for solid samples, a Shimadzu TOC 500 analyzer for dissolved C, a Hitachi UV2000 automated dual-beam spectrophotometer, several gas chromatographs with electron capture, flame ionization and thermal conductivity detectors, a Nikon compound microscope with epifluoresence and video imaging capabilities, 1 LiCor 6400 and 3 LiCor 6200 Portable Photosynthetic Systems (1/4 and 1 L cuvettes), a LiCor 6200 system dedicated for soil CO2 flux measurements, a LiCor 1600 null-balance porometer for stomatal conductance, and 3 pressure chambers (PMS model 1000) for measuring plant water status, 4 Tektronix cable testers (model 1502B) coupled to Campbell CR10 data loggers for TDR soil moisture measurements, a Troxler (model 3221) neutron probe gauge for soil moisture determinations, and a back-pack mounted minirhizotron (Bartz Technology Co. BTC-2) camera system. We also have access to a shared Hewlett Packard HPLC and GC/MS system for characterizing soluble organic compounds. Cold storage facilities for holding samples are available, as are sample preparation rooms for drying and grinding plant and soil samples.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

KNZ resources are used to support the hardware and software associated with the KNZ web site and data portal.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

The Konza Prairie LTER program contributes to increased public awareness of ecological and environmental issues (e.g., biodiversity
conservation, habitat loss, ecosystem services, restoration ecology, etc.) through outreach and public education activities, such as the Konza
Prairie biennial Visitors' Day and our docent-led public education programs. Konza LTER scientists also conduct an annual fire-training
course for researchers and local land managers (35-40 participants/year). In addition, the Konza LTER Program is increasingly called upon to
provide data relevant to resource management and regulatory policy. At a local level, Konza scientists participate in

Kansas Agricultural
Experiment Station public education events by providing information on the ecological consequences of various grassland management
practices (e.g., fire frequency and grazing). At the regional level, Konza Prairie scientists are advising EPA Region 7 staff and scientists on the
ecological benefits of fire in maintaining native tallgrass prairie habitat and diversity, including several meeting with both regional and national
EPA officials. This issue has become very important, as the potential impacts of grassland burning on regional air quality have been receiving
increasing scrutiny. Konza grazing studies are providing data that will be used to inform ranchers and land managers of the potential benefits of alternative management strategies. In the international arena, Konza Scientists have provided information on grassland management to scientists and park resource managers from South Africa, Australia, and Hungary, with many of these visits focusing on resource management issues of public concern. The Konza Prairie LTER database is also being used to address issues relevant to regulatory policy. Long-term data on Konza Prairie streamwater quality is providing a baseline for regional water quality in the absence of agricultural practices or other disturbances. LTER data on soil chemistry is also being incorporated into ongoing studies to evaluate the potential of grassland management practices to increase soil C sequestration to offset atmospheric CO2 loading.

Finally, the Konza Prairie LTER site, and the unique watershed fire and grazing treatments, have been the focus of several art-related activities. For example, local artist Edward Sturr produced limited edition hand-colored photographs and lithographs of Konza landscapes
(www.prairielight.com), and contributed the LTER Art exhibit at the National Science Foundation. The Konza Prairie Biological Station also provided on-site housing for a Visiting Writers series, in conjunction with the KSU English Department.

Changes

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.