Annual Report for Period: 11/2010 - 10/2011
Submitted on: 08/04/2011
Principal Investigator: Blair, John M.
Award ID: 0823341
Organization: Kansas State University
Submitted By:
Blair, John - Principal Investigator
Title:
Konza Prairie LTER VI: Grassland Dynamics and Long-Term Trajectories of Change

Project Participants

Senior Personnel

Name: Blair, John
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Blair is the Konza Prairie LTER lead PI and project director. Provides overall LTER project leadership and coordination. Research expertise in ecosystem ecology and terrestrial biogeochemistry; soil ecology, including decomposition, soil nutrient cycling, litter/soil/plant nutrient dynamics; effects of climate change and other disturbances on ecosystem processes; ecology of soil invertebrates; and restoration ecology.

Name: Hartnett, David
Worked for more than 160 Hours: Yes
Contribution to Project:
Konza LTER VI Co-PI and former Director of the Konza Prairie Biological Station (the primary research site for the Konza LTER program). Expertise in grassland plant population ecology; the role of belowground bud banks in grassland communities; plant mycorrhizal interactions in grasslands; plant-herbivore interactions; fire ecology. Also involved in ILTER activities, and Co-Director of the Institute for Grassland Studies.

Name: Joern, Anthony
Worked for more than 160 Hours: Yes
Contribution to Project:
Konza LTER VI Co-PI. Provides expertise on insect population and community studies; plant-herbivore-predator interactions; long-term consumer population dynamics; responses of insect herbivores to fire and grazing; temporal dynamics in ecological studies. Oversees the Konza LTER tong-term grasshopper abundance dataset, and studies on the role of insect herbivores and climate change in mesic grasslands. Is leading the new LTER VI patch-burning grazing study, and assessing impacts of fire-grazing interactions on spatial patterning. Co-Director of the KSU Institute for Grassland Studies (with D. Hartnett).

Name: Dodds, Walter
Worked for more than 160 Hours: Yes
Contribution to Project:
Konza LTER VI Co-PI. Dr. Dodds provides leadership for the Konza LTER aquatic research group. Research expertise in aquatic ecology; phycology; nutrient cycling and retention in streams; groundwater chemistry; watershed-level hydrologic export; water quality. Dr. Dodds is also leading the new reiparian vegetation removal study as part of the LTER VI funding cycle. This study will assess the impacts of riparian land-cover change on grassland streams.

Name: Nippert, Jesse
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Nippert is a co-PI on the Konza LTER VI project, and contributes expertise in plant ecology and ecophysiology, and plant responses to environmental variability and change. Dr. Nippert oversees the application of environmental sensor networks to assess spatial variability in microclimate, and plant responses on core LTER watersheds at the Konza Prairie LTER site. He also directs the KSU Stable Isotope Mass Spectroscopy Laboratory, and provides expertise on the application of stable isotopes to ecological studies.

Name: Knapp, Alan
Worked for more than 160 Hours: Yes

Contribution to Project:

Provides research expertise in grassland ecology, plant ecology, physiological ecology, global change studies, plants-herbivore interactions, invasive species ecology. Dr. Knapp also provides leadership for LTER studies of plant productivity and responses to climatic variability and climate change, and conducts multi-site research involving SGS and KNZ LTER sites. Supported by a subcontract to Colorado State University.

Name: Johnson, Loretta

Worked for more than 160 Hours: Yes

Contribution to Project:

Provides research expertise in plant ecology, plant-soil interactions, and ecological genomics. Oversees a long-term water x N amendment experiment at Konza Prairie, and is establishing a new study of the impacts of climate on success of local vs. non-local ecotypes of dominant grasses.

Name: Briggs, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Konza LTER investigator and Director of the Konza Prairie Biological Station (the primary research site for the Konza LTER program). Dr. Briggs oversees studies of grass-shrub interactions and the causes and consequences of woody plant encroachment into grasslands. Directs research into patterns and controls of ANPP in grasslands, as well as studies of the relationship between ANPP and species richness. Also provides expertise in database management, GIS and remote sensing studies.

Name: Gido, Keith

Worked for more than 160 Hours: Yes

Contribution to Project:

Provides expertise in aquatic ecology; stream communities and ecosystems; the effects of fish on stream ecosystem properties such as primary productivity, nutrient cycling, community structure (species richness and diversity), decomposition and transport of particulate organic matter (POM); impacts of altered hydrologic regimes on stream ecosystems. Oversees the LTER experimental stream facility. Coordinates regional assessments of stream fish communities.

Name: Goodin, Douglas

Worked for more than 160 Hours: Yes

Contribution to Project:

Provides expertise on remote sensing of ecological data, including patterns of plant productivity and spatial distributions of grazing and fire effects; research on climatology in the Central Plains (Dr. Goodin serves on the LTER Climate Committee); research on the impacts of burning on air quality.

Name: Koelliker, James

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in hydrologic modeling; soil water flux, and water-use by grassland plant communities. Dr. Koelliker is responsible for implementing irrigation treatments and soil moisture measurements for the long-term Irrigation Transect Study at Konza Prairie. Is in phased retirement, and will transfer his LTER duties to new LTER investigator, Dr. Stacy Hutchinson.

Name: Macpherson, Gwendolyn

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in hydrogeology; subsurface hydrology; long-term studies of groundwater flux and biogeochemistry at Konza LTER site. Supported by a subcontract to the University of Kansas.

Name: McKane, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

EPA Scientist (Corvallis, OR) with expertise in ecosystem modeling. He collaborates on research to assess the impacts of climate and management on ecosystem processes (productivity, hydrologic flux, biogeochemistry) at Konza Prairie, and the surrounding Flint Hills region. Currently working with scientists from EPA, Georgia Institute of Technology, and KSU to develop and apply the GTHM-PSM ecohydrology model to the Konza Prairie LTER site. GTHM-PSM links a land surface hydrology model (GTHM: Georgia Tech Hydrology Model) with a terrestrial biogeochemistry model (PSM: Plant-Soil-Model) in a

spatially-distributed (GIS) framework.

Name: Rice, Charles

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in soil microbial ecology; responses of grassland microbial communities to fire, grazing climatic variability; soil C and N dynamics; denitrification in grasslands; effects of management on soil C sequestration. Contributor and author for IPCC AR4.

Name: Sandercock, Brett

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in avian population ecology and conservation biology. Dr. Sandercock oversees long-term sampling of grassland bird populations at the Konza LTER site, and conducts research on factors that influence population dynamics of grassland bird species. Also collaborating with researchers in Uruguay to study population dynamics of Upland Sandpipers, a migratory bird species that breeds in North American tallgrass prairies. Co-PI for Konza Prairie site-based REU program during LTER VI.

Name: Collins, Scott

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in grassland ecology and plant community ecology; ecological analyses of spatial and temporal dynamics; ecological responses to disturbance; analysis of species distribution and abundance; local-regional interactions; productivity-diversity relationships.

Name: Ferguson, Carolyn

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in plant systematics, plant population biology, and plant-pollinator interactions. Dr. Ferguson oversees the KSU Herbarium, and also provides expertise on electronic databasing of biological collections. Dr. Ferguson is also PI of GK-12 grant, which includes students and faculty scientists from the Konza LTER program.

Name: Garrett, Karen

Worked for more than 160 Hours: Yes

Contribution to Project:

Provides expertise on plant diseases; epidemiology; role of plant pathogens in native plant communities; application of genomic approaches to plant ecology.

Name: Jumponnen, Ari

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise on fungal ecology, particularly mycorrhizae and other endophytic fungi; diversity of soil microbial communities; application of molecular methods to characterize soil microbial communities. Co-PI for Konza Prairie site-based REU program during LTER VI.

Name: Kaufman, Glennis

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise on the ecology of grassland mammals; long-term monitoring of small mammal population dynamics in relation to climate, management and land-cover changes. Responsible for overseeing LTER datasets on small mammal dynamics.

Name: Price, Kevin

Worked for more than 160 Hours: Yes

Contribution to Project:

Professor with joint appointments in Agronomy and Geography at KSU. Expertise on application of remote sensing approaches to the study of grasslands; development of remote sensing indices to assess spatial and temporal patterns of plant productivity, grazing intensity, woody plant cover, etc.

Name: Whiles, Matt

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in invertebrate ecology; research focused on assessment of patterns and controls of secondary productivity in grassland streams; ecology of soil invertebrates in grasslands. Participant in new riparian vegetation removal experiment. Supported by subcontract to Southern Illinois University.

Name: Zolnerowich, Gregory

Worked for more than 160 Hours: Yes

Contribution to Project:

Expertise in grassland insect biodiversity and insect systematics, particularly of parasitic wasps. Dr. Zolnerowich oversees the KSU Museum of Entomological and Prairie Arthropod Research, and provides expertise on electronic databasing of biological collections.

Name: Kaufman, Donald

Worked for more than 160 Hours: Yes

Contribution to Project:

Research focus is on the ecology of small mammals, and temporal and spatial dynamics of consumer populations in grasslands.

Name: Wisely, Samantha

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Wisely is a wildlife population biologist, with expertise in uses of both ecological and molecular tools to investigate how environmental change affects biological processes at multiple scales. Her Konza-related research includes studies of how human-induced habitat changes affects the population dynamics and connectivity of carnivores, and epidemiological processes associated with wildlife vectors.

Name: Baer, Sara

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Baer provides expertise on grassland restoration, particularly with respect to plant community dynamics and long-term changes in ecosystem properties and processes. She is responsible for directing research on grassland restoration ecology at the Konza site, including recovery of ecosystem properties in restored grasslands, and the influence of genotypic differences in cultivars and native vegetation on ecological processes in restored grasslands. Dr. Baer oversees the new Restoration Chronosequence study being initiated as part of the LTER VI project. Supported with a subcontract to Southern Illinois University.

Name: Harrington, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Harrington is a Professor of Geography with expertise in climatology and climate change, land-use/land-cover change, and natural resource applications of remote sensing and GIS. Dr. Harrington is leading many of the new social science related initiatives within our LTER program, and has been representing the KNZ LTER program at numerous LTER Network social science planning and cross-site activities (valuation of ecosystem services, impacts of land-cover change, etc.).

Name: McLauchlan, Kendra

Worked for more than 160 Hours: Yes

Contribution to Project:

Research at Konza includes studies of plant pollen as indicators of plant community change in the Central Plains, and uses of stable isotopes and tree rings as indicators of past climates.

Name: Craine, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:

Research Assistant Professor at KSU. Research at Konza includes studies of plant traits in relationship to species distributions; studies of bison grazing; and studies of soil biogeochemistry.

Name: Fay, Philip

Worked for more than 160 Hours: Yes

Contribution to Project:

USDA/ARS scientist and LTER collaborator. Research expertise in plant ecology and plant ecophysiology; impacts of climatic variability and climate change in grasslands; plant-insect interactions.

Name: Horne, Eva

Worked for more than 160 Hours: Yes

Contribution to Project:

Research in behavioral ecology of grassland reptiles; responses of reptile and amphibian populations to fire and grazing. Dr. Horne also assists with administration of the Konza Prairie Biological Station, and coordination of research permits and projects at the site.

Name: Wilson, Gail

Worked for more than 160 Hours: Yes

Contribution to Project:

Gail Wilson provides expertise on the role of mycorrhizal fungi in grasslands, and is responsible for long-term studies of the impacts of of mycorrhizal fungi on plant community dynamics and on soil structure and C storage in grasslands. She is supported with subcontract to Oklahoma State University.

Name: Smith, Melinda

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Smith is currently Assistant Professor at Yale University. She and her students are conducting research on plant population and community dynamics at Konza Prairie, and the impacts of climate change. She also directs site-based activities related to the multi-site Nutrient Network (NutNet) project. Supported with a subcontract to Yale University.

Name: Olson, K

Worked for more than 160 Hours: Yes

Contribution to Project:

KC Olson is an associate professor animal science, who brings expertise on the physiology and management of cattle in mesic grasslands. Dr. Olson is an active participant in the new patch-burn grazing study, and will oversee assessment of animal performance as a management-related aspect of this LTER study.

Name: Hutchinson, Stacy

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Hutchinson is a Professor of Biological and Agricultural Engineering, and has assumed responsibility for overseeing the water addition treatments and soil moisture monitoring in the long-term Irrigation Transect Experiment at the Konza site. This was previously the responsibility of Dr. Jim Koelliker until his retirement in 2010

Name: Daniels, Melinda

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Melinda Daniels is an Assistant Professor of Geography and new senior personnel with the Konza LTER program. Her research expertise is in fluvial geomorphology and she has initiated new measurements of stream morphology, erosion and sediment transport at the Konza Prairie LTER site.

Post-doc

Name: Laws, Angela

Worked for more than 160 Hours: Yes

Contribution to Project:

Angela Laws is a post-doctoral associate working with Dr. Tony Joern on studies of grasshopper herbivory, and the impacts of climate change on tri-trophic interactions in grassland invertebrate food webs at Konza Prairie.

Graduate Student

Name: Avolio, Meghan

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student at Yale University (Advisor: Melinda Smith). Research on grassland plant communities, mycorrhizae, climate change, nitrogen deposition, and genetic structure of plant communities.

Name: Bowe, Sarah

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: Samantha Wisely). Research on exurbanization and woody expansion in the Flint Hills: the influence of habitat configuration on host ecology and rabies epidemiology. Completed 2010.

Name: Carter, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student (Advisor: John Blair). Research on factors influencing trajectories of recovery in tallgrass prairie restorations. Serves as KNZ graduate student representative. Participant in the KSU GK-12 program.

Name: Carter, Jacob

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: Jesse Nippert). Studies of the ecophysiology of an invasive species in western grasslands. Completed 2010.

Name: Chang, Cynthia

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student at Yale University (Advisor: Melinda Smith). Research on grassland community and ecosystem ecology, plant population biology.

Name: Klug, Page

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. graduate student (Advisor: Kim With). Studying interactions between grassland birds and their snake predators. Completed 2010.

Name: Koerner, Sarah

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student from the University of New Mexico (Advisor: Scott Collins). Research on plant community and ecosystem responses to fire, grazing and climate, using a combination of sites/experiments in North America (Konza Prairie) and South Africa (Kruger National Park). Ms. Koerner is currently supported with an NSF Doctoral Dissertation Improvement Grant.

Name: LaPierre, Kimberly

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student from Yale University, working with Dr. Melinda Smith on plant responses to altered nutrient availability and grazing (part of the cross-site NutNet project).

Name: Lease, Amanda

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student from Colorado State University, working with Dr. Alan Knapp on ecotypic variation in dominant grass species in tallgrass prairie and shortgrass steppe. Field work is being done at the KNZ and SGS LTER sites.

Name: Ott, Jacquiline

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D student working with Dr. Dave Hartnett. Belowground bud bank phenology and its contribution to grass plant architecture.

Name: Parsons, Sheena

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: Tony Joern). Research on grasshoppers and herbivory in tallgrass prairie.

Name: Reisinger, Alex

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student (Advisor: Walter Dodds). Studies of spatial and temporal variation of stream and riparian denitrification: the influence of riparian vegetation. Completed 2010.

Name: Riley, Alyssa

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D. student (Advisor: Walter Dodds). Stream ecosystem response to woody expansion

Name: Rolfsmeier, Susan

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student working in the area of plant systematics (Advisor: Carolyn Ferguson).

Name: Rostkowski, Steven

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student working with Dr. John Blair on soil invertebrate ecology, and responses of soil communities to climate change.

Name: Throop, Emilie

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: Kim With). Studying landscape pattern and distribution of reptiles at Konza Prairie LTER site.

Name: Tucker, Sally

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: Jesse Nippert). Studying the use of plant-based traits to explain the success and relative abundance of individual species in grassland communities.

Name: VanderWeide, Ben

Worked for more than 160 Hours: Yes

Contribution to Project:

M.S. student (Advisor: David Hartnett). Research on the role of bud banks in tallgrass prairie stability and invasibility

Name: Whiting, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate student at Southern Illinois University (Advisor: Matt Whiles). Research on longitudinal patterns of macroinvertebrate production, energy flow, and trophic structure in a tallgrass prairie stream

Name: Sousa, Bridget

Worked for more than 160 Hours: Yes

Contribution to Project:

Ph.D student from the University of Kentucky working at Konza Prairie in the area of avian ecology.

Name: An, Nan

Worked for more than 160 Hours: Yes

Contribution to Project:
Nan An is a Ph.D. student in the Dept of Geography, working with Dr. Kevin Price on using remotely-sensed data to scale ground-based estimates of ANPP to achieve watershed-to-regional estimates of plant productivity in the Flint Hills region. This research is utilizing remote sensing imagery and Konza Prairie LTER estimates of ANPP from core LTER watersheds at the Konza Prairie Biological Station.

Name: Hoover, David

Worked for more than 160 Hours: Yes

Contribution to Project:
Ph.D. student from Colorado State University (Advisor: Alan Knapp) studying the impacts of climate change in Central Plains grasslands.

Name: Winders, Kyle

Worked for more than 160 Hours: Yes

Contribution to Project:
M.S. student (Advisor: Walter Dodds) studying stream and riparian responses to patch-burning and grazing. Completed 2010.

Name: Gomez, Jesus

Worked for more than 160 Hours: Yes

Contribution to Project:
MS student from Puerto Rico working with Dr. Tony Joern on role of grassland disturbance on arthropod food webs.

Name: Hartman, Jeffrey

Worked for more than 160 Hours: Yes

Contribution to Project:
MS Thesis, Responses of switchgrass (Panicum virgatum L.) to precipitation amount and temperature, completed in 2011. Advisor, Jesse Nippert.

Name: Ratajczak, Zak

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student working with Dr. Jesse Nippert. Research area involves woody encroachment.

Name: Killian, Paul

Worked for more than 160 Hours: Yes

Contribution to Project:
MS student (Advisor: John Briggs) working on impacts of fire on prairie vegetation.

Name: Schneider, Theresa

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (Advisor: Sam Wisely) working on host ecology on KPBS.

Name: Tsypin, Misha

Worked for more than 160 Hours: Yes

Contribution to Project:
Has begun his M.S. thesis research, with Dr. G.L. Macpherson, at the 2-4 Mor - 2-5 Mor well sites, refurbishing the soil lysimeters at 2-5 Mor site, and installing soil-gas samplers. He is comparing soil- and groundwater chemistry and gases, dissolved species and stable isotopes, before and immediately after major rainfall events.

Name: Robbins, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:
Ph.D. aspirant,(Advisor: G.L.Macpherson) is in the research and design phases for work planned to be located, in part, in the N04d watershed at Konza. He is designing a soil-gas monitoring system.

Name: Martin, Erika

Worked for more than 160 Hours: Yes

Contribution to Project:
Studying the inter- and intra-specific interactions among prairie stream fish species found in Kings Creek on Konza Prairie (Advisor: Keith Gido).

Name: Veach, Allison

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Walter Dodds) working on riparian woody vegetation removal.

Name: Forrestel, Elisabeth

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Melinda Smith at Yale) working with population genetics in tallgrass plant species.

Name: Soong, Jenny

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Francesca Cotrufo in Soil and Crop Science at CSU) working on soil carbon cycling.

Name: Wilcox, Kevin

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Alan Knapp in GDPE/Biology at CSU) working on grassland plant community and ecosystem ecology.

Name: Russell, Danelle

Worked for more than 160 Hours: Yes

Contribution to Project:
MS student (advisor, Walter Dodds) working in the area of water quality and amphibians with the Patch Burn Experiment on Konza.

Name: Ricketts, Andrew

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Sam Wisely) working with small mammal responses to patch burn grazing.

Name: Gastineau, Elizabeth

Worked for more than 160 Hours: Yes

Contribution to Project:
MS student (advisor, David Hartnett) working on invasive plant population biology.

Name: Klopf, Ryan

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Sara Baer at SIU) working on temporal changes in ecosystem functions such as soil C and N cycling in high and low diversity prairie restorations.

Name: Erndt, Kim

Worked for more than 160 Hours: Yes

Contribution to Project:
PhD student (advisor, Matt Whiles at SIU) examining some of the biological responses to restoration efforts in the headwaters of a prairie stream watershed located on Konza Prairie.

Name: Sylvain, Zac

Worked for more than 160 Hours: Yes

Contribution to Project:

PhD student (advisor, Diana Wall in Biology at CSU) working on belowground faunal responses to climate change.

Name: Vandermyde, Jodi
Worked for more than 160 Hours: Yes
Contribution to Project:
MS student (advisor, Matt Whiles at SIU) examining aquatic invertebrates and organic matter of two streams on Konza Prairie in Kansas before and after a prairie restoration method of removing all vegetation covering the stream.

Name: Carson, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:
MS student working with John Blair. Research area is 'Long-term responses of a grassland ecosystem to fire and nutrient additions'.

Name: Raynor, Edward
Worked for more than 160 Hours: Yes
Contribution to Project:
Anthony Joern and John Briggs are co-advisors. Research subject is herbivore foraging with an emphasis on bison.

Name: Williamson, Melinda
Worked for more than 160 Hours: Yes
Contribution to Project:
MS thesis, Controls on bud activation and tiller initiation in tallgrass prairie: The effect of light and nitrogen, completed 2010 (Advisor, Gail Wilson at OSU).

Undergraduate Student

Name: Balsters, John
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Barrick, James
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Fabrycky, Caleb
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Heasty, Ben
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with collection and processing of LTER samples.

Name: Heasty, Rod
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kurtz, Travis
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Legler, Meagan
Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Mathews, Brad
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Meyer, Nick
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Orlowski, Kathryn
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with collection and processing of LTER samples.

Name: Ruder, Gloria
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Schmeidler, Megan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Schreck, Whitney
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Seibel, Caleb
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Stephan, Mark
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Sullivan, Brian
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Tulp, Kevin
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with collection and processing of LTER samples.

Name: Tyner, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Van Allen, Jake
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Wilson, Jake
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Woodroof, Ike
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Wood, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Young, Sean
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kohler, Brady
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Miles, Samantha
Worked for more than 160 Hours: Yes
Contribution to Project:
data entry

Name: Doll, Rebecca
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Falls, Julianna
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Mathews, Elliot
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Mau, Marvin
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Calhoun, Michelle
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with collection and processing of LTER samples.

Name: Welti, Ellen
Worked for more than 160 Hours: Yes
Contribution to Project:
Works with arthropod food webs under Dr. Tony Joern.

Name: Tatarko, Anna
Worked for more than 160 Hours: Yes
Contribution to Project:
Works with arthropod food webs under Dr. Tony Joern.

Name: Sheldon, Wade
Worked for more than 160 Hours: Yes
Contribution to Project:
Works with arthropod food webs under Dr. Tony Joern.

Name: Stowers, Mark
Worked for more than 160 Hours: Yes
Contribution to Project:
Undergrad Honors student working with bison behavior under Dr. Tony Joern.

Name: Lickteig, Spencer
Worked for more than 160 Hours: Yes
Contribution to Project:
Working under Dr. Ari Jumpponen on contemporary evolution in fungal communities led by anthropogenic stressors.

Name: Orozco, Gracie
Worked for more than 160 Hours: Yes
Contribution to Project:
Working in the lab of Dr. Jesse Nippert.

Name: Culbertson, Teall
Worked for more than 160 Hours: Yes
Contribution to Project:
Working in the lab of Dr. Jesse Nippert.

Name: Jackson, Whitley
Worked for more than 160 Hours: Yes
Contribution to Project:
Working in the lab of Dr. Jesse Nippert.

Name: Armstrong, Graham
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with sorting of plant material and field work.

Name: Frerker, Maggie
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with lab analyses.

Name: Kentopp, Brandon
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with sorting of plant material and field work.

Name: Miller, Amanda
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with sorting of plant material and field work.

Name: Ott, Luke
Worked for more than 160 Hours: Yes

Contribution to Project:
Assists with sorting of plant material and field work.

Name: Wilson, Nick
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with sorting of plant material and field work.

Name: Schreiner, Spencer
Worked for more than 160 Hours: Yes
Contribution to Project:
Assists with sorting of plant material and field work.

Name: Siders, Adam
Worked for more than 160 Hours: Yes
Contribution to Project:
Working with Dr. Sam Wisely. Analyzed and presented the KPBS deer population study.

Name: Huff, Breanna
Worked for more than 160 Hours: Yes
Contribution to Project:
Completed her Honors' Thesis (undergraduate)under G.L.Macpherson, comparing water chemistry from 1991-1993 to samples she collected in 2008-2009 in a nest of wells on the east side of the N04d stream, about 36 m from the riparian zone. She showed that alkalinity increased about 15% over that time period, and in situ pH decreased by more than 0.5 pH units, corroborating findings from Macpherson et al., 2008, who found similar results in wells near or within the encroaching woody riparian zone (Huff and Macpherson, 2009).

Name: Ohmes, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:
Completed her undergraduate research project under G.L Macpherson, quantifying the CO2 loss from about 400 m of the lower portion of the N04d stream (Ohmes et al., 2009). This will become part of the calculation of the carbon balance sheet for the watershed, in progress.

Name: Sonnentag, Tammy
Worked for more than 160 Hours: Yes
Contribution to Project:
Works under information management providing data entry services.

Name: Estes, Courtney
Worked for more than 160 Hours: Yes
Contribution to Project:
Part-time support for GIS and mapping project.

Name: Atwell, Taylor
Worked for more than 160 Hours: Yes
Contribution to Project:
Technical support for field work.

Name: Johnson, Elizabeth
Worked for more than 160 Hours: Yes
Contribution to Project:
Technical support for field work.

Name: O'Brien, Joy
Worked for more than 160 Hours: Yes
Contribution to Project:

Technical support for field work.

Name: Thompson, Nate
Worked for more than 160 Hours: Yes
Contribution to Project:
Technical support for field work.

Name: Wendt, Nathan
Worked for more than 160 Hours: Yes
Contribution to Project:
Atmospheric Science student, will aid in efforts related to the eddy covariance towers at Konza. Working with Nathaniel Brunsell at KU.

Name: McCrea, Evan
Worked for more than 160 Hours: Yes
Contribution to Project:
undergraduate research assistant working on restoration ecology projects through SIUC Undergraduate Assistantship

Name: Leloneck, Nick
Worked for more than 160 Hours: Yes
Contribution to Project:
undergraduate research assistant working on restoration ecology projects

Technician, Programmer

Name: Towne, Gene
Worked for more than 160 Hours: Yes
Contribution to Project:
Research scientist; long-term plant community data; grazing studies.

Name: Ramundo, Rosemary
Worked for more than 160 Hours: Yes
Contribution to Project:
LTER analytical lab supervisor; research cooridinator.

Name: Kuhl, Amanda
Worked for more than 160 Hours: Yes
Contribution to Project:
research assistant; field crew leader

Name: O'Neal, Patrick
Worked for more than 160 Hours: Yes
Contribution to Project:
research assistant, field technician

Name: Taylor, Jeff
Worked for more than 160 Hours: Yes
Contribution to Project:
research assistant, field technician

Name: Choubey, Rahul
Worked for more than 160 Hours: Yes
Contribution to Project:
Providing part-time support to the information manager as an assistant programmer. The primary focus of this position is in web-site and content management development. Expected products from his services include a new web site as well as a content management portal.

Name: Subramanian, Arthi

Worked for more than 160 Hours: Yes

Contribution to Project:

Providing part-time support to the information manager as an assistant programmer. The primary focus of this position is in web-site and content management development. Expected products from his services include a new web site as well as a content management portal.

Name: Anusha Nukala, Leela

Worked for more than 160 Hours: Yes

Contribution to Project:

Providing part-time support to the information manager as an assistant programmer. The primary focus of this position is in web-site and content management development. Expected products from his services include a new web site as well as a content management portal.

Other Participant

Name: Skibbe, Adam

Worked for more than 160 Hours: Yes

Contribution to Project:

LTER Information Manager. His responsibilities include data management, database design and implementation, and overseeing KNZ LTER computer network activities. Mr. Skibbe also provides GIS support and expertise for the Konza LTER program.

Name: Gadbury, Carol

Worked for more than 160 Hours: Yes

Contribution to Project:

LTER Program Assistant. Provides administrative support for the management and operation of LTER programs.

Name: Wright, Valerie

Worked for more than 160 Hours: Yes

Contribution to Project:

Educational Coordinator, SLTER program

Name: Baker, Annie

Worked for more than 160 Hours: Yes

Contribution to Project:

assistant for the Konza SLTER program

Research Experience for Undergraduates

Name: Graver, Tina

Worked for more than 160 Hours: Yes

Contribution to Project:

(Mentor: Kendra McLauchlan)

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: Ohio Wesleyan University, OH

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2009

REU Funding: REU site award

Name: Hixon-Bowles, Kelsey

Worked for more than 160 Hours: Yes

Contribution to Project:

(Mentor: Mike Herman)

Years of schooling completed: Freshman
Home Institution: Same as Research Site
Home Institution if Other:
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Kearns, Brian
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Whitman College, WA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Keith, Rose
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Mark Ungerer)

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Mount Holyoke College, MA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Nielsen, Matt
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Ted Morgan)

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Grinnell College, IA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Pavlovic, Nathan
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Ruth Welti)

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Grinnell College, IA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Presuma, Dumi

Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Walter Dodds)

Years of schooling completed: Junior
Home Institution: Same as Research Site
Home Institution if Other: Bethune-Cookman University, FL
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU supplement

Name: Ratajczak, Zakary
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Jessie Nippert)

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Vassar College, NY
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Spurr, Rebecca
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Joe Craine)

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: St. Olaf College, MN
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Wilson, Maya
Worked for more than 160 Hours: Yes
Contribution to Project:
(Mentor: Eva Horne)

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Franklin and Marshall College, PA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Sterne, Gabriela
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Whitman College, WA
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2009
REU Funding: REU site award

Name: Ross, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: California State University - Monterey Bay
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement

Name: Novick, Aaron
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: The College of Wooster
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement

Name: Foo, Cecily
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Whitman College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement

Name: Ballinger, Kristen
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Whitman College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement

Name: Wieme, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site

Home Institution if Other: St. Olaf College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Bratt, Anika
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: St. Catherine University
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Lambert, Jon
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: St. Olaf College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Kahl, Hanna
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Whitman College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Heatherington, Chelsea
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of Florida
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Delfing, Elizabeth
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Capital University
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Singer, Caitlin
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Other
Home Institution: Other than Research Site
Home Institution if Other: Arizona State University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Bennett, Amanda
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Yale University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Song, Runqi
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Freshman
Home Institution: Other than Research Site
Home Institution if Other: Yale University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Potter, Arjun
Worked for more than 160 Hours: Yes
Contribution to Project:

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Cornell University
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement
Name: Gelderman, Theodore
Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: Carleton College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2010
REU Funding: REU supplement

Name: Klodd, Annie
Worked for more than 160 Hours: Yes
Contribution to Project:
Jesse Nippert, mentor

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: Grinnell College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2011
REU Funding: REU supplement

Name: Castillo Rivera, Nelson Gabriel
Worked for more than 160 Hours: Yes
Contribution to Project:
Whitfield/Rotenberg mentors

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Puerto Rico at Mayaguez
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2011
REU Funding: REU supplement

Name: Blanchard, Benjamin
Worked for more than 160 Hours: Yes
Contribution to Project:
Anthony Joern, mentor

Years of schooling completed: Sophomore
Home Institution: Other than Research Site
Home Institution if Other: University of Michigan - Ann Arbor
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2011
REU Funding: REU supplement

Name: Patterson, Judith
Worked for more than 160 Hours: Yes
Contribution to Project:
Mather, mentor

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: University of Illinois -Champaign-Urbana
Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree
Fiscal year(s) REU Participant supported: 2011

REU Funding: REU supplement

Name: Glover, Mary

Worked for more than 160 Hours: Yes

Contribution to Project:

Marshall, mentor

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of Tennessee-Knoxville

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2011

REU Funding: REU supplement

Name: Levy, Charlotte

Worked for more than 160 Hours: Yes

Contribution to Project:

Ungerer, mentor

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Skidmore College

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2011

REU Funding: REU supplement

Name: Sullivan, Rebecca

Worked for more than 160 Hours: Yes

Contribution to Project:

Morgan, mentor

Years of schooling completed: Junior

Home Institution: Other than Research Site

Home Institution if Other: University of Dallas

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2011

REU Funding: REU supplement

Name: Bansbach, Lauren

Worked for more than 160 Hours: Yes

Contribution to Project:

Dodds/Russell, mentors

Years of schooling completed: Sophomore

Home Institution: Other than Research Site

Home Institution if Other: Missouri State University

Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree

Fiscal year(s) REU Participant supported: 2011

REU Funding: REU supplement

Name: Zarate, Patricia

Worked for more than 160 Hours: Yes

Contribution to Project:

Jumpponen/Brown, mentors

Years of schooling completed: Freshman

Home Institution: Other than Research Site

Home Institution if Other: Swarthmore College
Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree
Fiscal year(s) REU Participant supported: 2011
REU Funding: REU supplement

Name: Daniels, Lynsey
Worked for more than 160 Hours: Yes
Contribution to Project:
Hartnett/Nippert, mentors

Years of schooling completed: Junior
Home Institution: Other than Research Site
Home Institution if Other: St. Joseph's University
Home Institution Highest Degree Granted(in fields supported by NSF): Master's Degree
Fiscal year(s) REU Participant supported: 2011
REU Funding: REU supplement

Organizational Partners

The Nature Conservancy
Konza Prairie Biological Station is a Nature Conservancy site, established on land purchased by the Nature Conservancy and managed by the Division of Biology at KSU. Konza LTER scientists interact with TNC scientists and officers on a broad range of management-related issues, including grassland conservation, restoration ecology, and grazing management.

USGS
The USGS collects and provides data on the hydrology and chemistry of Kings Creek, a USGS benchmark stream located on the Konza Prairie LTER site, and the Konza LTER program facilitates the transfer of these data to the Hydro-DB database. The Konza LTER site is also a part of the USArray component of the USGS EarthScope project- a continental-scale seismic observatory.

U S Department of Energy
DOE, through the National Institute for Climate Change Research (NICCR) program, provides partial financial support for a long-term study of grassland responses to climate change being conducting at the Konza LTER site (the Rainfall Manipulation Plots (RaMPs) project]. In addition, DOE funding through the Office of Biological and Environmental Research (BER) supports research at the Konza LTER site to link genetic and genomic responses of plant species to community and ecosystem responses to key environmental drivers (led by Dr. Melinda Smith, Yale University, with several KNZ LTER collaborators). The most recent of these projects (The Climate Extremes Experiment (CEE)initiated in 2010) is examining threshold responses of the tallgrass prairie ecosystem to temperature and precipitation extremes. Finally, the Konza LTER program provides support for a CO2 flux tower site,which is part of the Ameriflux network of net C exchange measurement sites.

Kansas State of
The state of Kansas provides an operating budget for Konza Prairie Biological Station personnel and general site maintenance.

Environmental Protection Agency
The US EPA jointly operates a CASTNet (Clean Air Standards and Trends Network) site located at the Konza Prairie LTER site. The Konza Prairie LTER program provides site support and the EPA provides analytical services and compiles data on atmospheric nutrient concentrations, dry deposition rates, and tropospheric ozone concentrations. The EPA Region 7 office also supports a collaborative modeling project, which is using using Konza LTER data to build linked models of hydrology and biogeochemistry that can be used to assess the effects of alternate land-use scenarios in the Flint Hills region. This project is led by Drs. Bob McKane (EPA) and Mark Stigglet (Georgia Tech), in collaboration with LTER PIs John Blair, John Briggs, Doug Goodin and Loretta Johnson.

Southern Illinois University at Carbondale
Collaborative Konza LTER research is supported by subcontracts to: (1) Dr. Matt Whiles and students to support research on stream invertebrate ecology and soil macroinvertebrate ecology; (2) Dr. Sara Baer and students to support research on grassland restoration ecology.

NASA

NASA provides financial and logistical support, and access to remotely sensed data, for remote sensing studies at the Konza LTER site. NASA also operates, with Konza LTER support, a Cimel sun photometer at the site. Konza Prairie LTER research sites have also served as validation sites for MODIS, and other NASA sponsored programs.

University of Kansas Main Campus

Dr. Gwen Macpherson (Dept of Geology) and her students conduct collaborative research on groundwater hydrology and chemistry as part of the Konza Prairie LTER program. We also provide a subcontract and logistical/technical support to Dr. Nathaniel Brunsell(Dept of Geography), who oversees flux tower operations at the Konza site. Dr. Brunsell's research addresses the role of land-use/land-cover change land surface heterogeneity in vegetation, moisture, soil type, topography on water and energy fluxes from local to regional scales. This research uses a combination of field measurements, remote sensing and numerical modeling, and is integrated with flux tower studies at the Konza LTER site. Finally, Dr. Sharon Billings and her students are conducting research on the effects of variable rainfall amounts across a natural precipitation gradient on soil microbial communities, which includes Konza Prairie as a study site. The Konza LTER program provides logistical support for these studies, and several Konza LTER PIs (Blair, Nippert) are collaborators in these projects.

National Oceanic and Atmospheric Administration (NOAA)

Konza Prairie is part of the U.S. Climate Reference Network (USCRN). USCRN is a network of climate stations developed as part of a National Oceanic and Atmospheric Administration (NOAA) initiative. Its primary goal is to provide future long-term homogeneous observations of temperature and precipitation that can be coupled to long-term historical observations for the detection and attribution of present and future climate change. Data from the USCRN is used in operational climate monitoring activities and for placing current climate anomalies into an historical perspective. The USCRN also provides the United States with a reference network that meets the requirements of the Global Climate Observing System (GCOS).

Colorado State University

Dr. Alan Knapp (Biology Department, Colorado State University) collaborates on many aspects of the Konza LTER program. His research includes studies of grassland ecology, plant ecophysiology, responses to climatic variability and climate change, and the ecology of plant invasions. Knapp's LTER research is supported by a subcontract to Colorado State University,which also provides support for students participating in cross-site research that utilizes the Konza Prairie LTER site and database. Grants to Knapp at CSU also support other LTER-related activities at the Konza site (e.g., climate change studies in RaMPs experiment, comparative studies of ecological processes in North American and South African grasslands). Blair and Gene Kelley (SGS PI) also collaborate on research on soil weathering and P availability across Great Plains climatic gradients.

University of New Mexico

Collaboration with Dr. Scott Collins and students in studies of plant community dynamics and long-term responses to fire, grazing, climatic variability and nutrient additions. Dr. Collins conducts long-term measurements of plant species richness and diversity in several key LTER experiments, and the Konza LTER program supports research visits by Dr. Collins and his students, and assists with the implementation and maintenance of long-term experiments under his direction (e.g., the P addition experiment). Collins, Blair, Knapp and M. Smith are also collaborators on a study of ecological convergence in North American and South African grasslands.

Yale University

Dr. Melinda Smith of Yale University is an LTER collaborator and participates in several aspects of Konza LTER research, including studies of plant community dynamics, the ecology of plant invasions, genomic responses of plants to climate change, and comparisons of the ecology of North American and South African grasslands. Dr. Smith and her students also oversee the NutNet project at Konza as apart of a multi-site study of the effects of nutrient amendments and herbivory on herbaceous community and ecosystem dynamics. The Konza LTER program provides a subcontract to Yale University and logistical support for these studies. Several other KNZ co-PIs are collaborators on the DOE-funded ecological genomics studies being conducted at the Konza LTER site, as well as the NSF-funded study of ecological responses to fire and grazing in North American and South African grasslands.

USDA CSREES

The Konza Prairie LTER site is part of the USDA CREES supported National Atmospheric Deposition Program (NADP), a network of more than 200 sites that monitors precipitation chemistry in the US. Konza Prairie support staff maintain the NADP collection equipment, and oversee local sample collection and processing. The NADP program provide sample analyses and data access. NADP is supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under agreement no. 2002-39138-11964.

Oklahoma State University

The Konza LTER program provides a subcontract to Oklahoma State University to support collaborative research with Dr. Gail Wilson. Dr. Wilson's research focuses primarily on the role of mycorrhizae in grasslands, and the the ecology of Bothriochloa bladhii (Caucasian bluestem), an important invasive grass species.

Averaves - Investigaci?n y Conservaci?n

In 2008, with supplemental NSF funding, we initiated an international collaboration with researchers in Uruguay to expand ongoing studies of the demography of Upland Sandpipers (Bartramia longicauda), a migratory shorebird that breeds in the temperate grasslands of North America, and winters in the pampas of Uruguay and Argentina. Understanding seasonal components of demography is relevant for understanding the life-history strategies of migratory birds, and for identifying the environmental factors that determine population dynamics. This study builds on the efforts of Konza LTER co-PI Brett Sandercock, whose long-term studies of the biology of Upland Sandpipers have yielded extensive demographic data from Konza Prairie during the breeding period in the northern hemisphere. The objective of this international initiative is to expand our demographic study to examine the ecology of Upland Sandpipers during the nonbreeding period of their life-cycle in Uruguay. The study is being conducted in collaboration with Matilde Alfaro of Barrios of Averaves - a conservation research group for birds based in Montevideo, Uruguay.

University of Oklahoma Norman Campus

Kansas State University and the University of Oklahoma are partners (along with the University of Kansas and Oklahoma State University) in a Track II EPSCoR Program to develop a cyberCommons for ecological forecasting. A large portion of the research involves enhancing field sensor networks and data transmission capabilities at the Konza LTER site, and using Konza data to inform and validate ecosystem models being developed and parametrized at OU.

Other Collaborators or Contacts

The Konza Prairie LTER program serves as a platform for collaborative research involving numerous scientists from KSU and from other institutions. The infrastructure, long-term experiments and databases supported by the LTER program facilitates interactions between scientists with diverse disciplinary interests and expertise, and has led to numerous collaborative interactions of Konza LTER scientists and investigators from other institutions around the world. Here we highlight a few of the collaborations taking place during the LTER VI funding period.

Since 1996, Konza Prairie has been a part of a network of flux tower sites, providing long-term measurements of carbon dioxide, water vapor, and energy exchange through the eddy covariance technique. Between 2006 and 2010, we expanded our studies of terrestrial ecosystem-atmosphere exchange, by adding two additional towers at the Konza Prairie Biological Station (KPBS) and one tower at the Nelson Environmental Study Area (NESA) with additional support from the Kansas NSF EPSCoR program. At Konza Prairie, new eddy covariance equipment for monitoring CO2, H2O and energy fluxes was installed on watersheds 1D (annually burned) and 4B (burned every four years). The Konza site now has continuous data streams from multiple towers allowing comparison of fluxes from 1) different landscape positions (annually burned uplands vs. lowlands); 2) different land-use regimes (annual vs. intermediate prescribed fire frequencies), and 3) areas with different plant community/life-forms (grass-dominated vs. significant woody vegetation expansion. A new eddy covariance tower was also installed in 2007 at the Nelson Environmental Study Area (NESA) outside of Lawrence, KS. The data stream from this tower has been integrated with Konza LTER towers to provide important new information on C flux in an area with higher annual precipitation and greater forest development than the KPBS site.

The Konza Prairie site has been part of the National Atmospheric Deposition Program (NADP) since 1982, and in 2002, Konza became a site for the EPA Clean Air Standards and Trends Network (CASTNet). In 2003 Konza became a site in NOAA's US Climate Reference Network (USCRN). Data from these networks continue to contribute to national monitoring programs, and provide important site-specific data for use by the Konza Prairie LTER program. In turn, the Konza LTER program supports these programs through cooperative instrument maintenance and sample collection, where appropriate.

Because of the long-term, watershed-level experimental treatments maintained as part of the Konza LTER program, and the availability of multiple long-term datasets and archived samples for these watersheds, the Konza Prairie LTER site continues to be a focal site for researchers from other institutions. A few examples of collaborative studies conducted at the Konza Prairie site during the LTER VI funding period include:

- assessing the role of evolutionary trade-offs in enzyme activities in microbial community function, led by Mark Bradford (Yale), Noah Fierer (U Colorado) and Rebecca McCulley (U Kentucky)

- a cross-site comparison of soil microbial-plant interactions in fertilized and unfertilized soil, led by Katie Suding (UC Berkeley)

- isotopic approaches to separate heterotrophic and autotrophic sources of soil CO2 and their responses to warming and altered precipitation in grassland ecosystems, led by Dr. Weixin Cheng, UC Santa Barbara

- studies of the patterns and controls of soil black carbon storage, a multi-site study directed by Johannes Lehmann (Cornell University);

- studies of trace gas flux from mesic grasslands led by Emily Elliott (University of Pittsburgh)

- stable isotope studies of litter decomposition directed by Francesca Cotrufo (Colorado State University);

- studies of soil microbial community composition, C cycling and responses to altered precipitation patterns, a multi-investigator project directed by Dave Myrold (U of Oregon);

- modeling of ecosystem responses to climate change and land management, directed by Bob McKane (EPA);

- studies of the role of dissolved organic C in streams from a range of ecosystem types, directed by Dr. Rudolph Jaffee (Florida International University)

- a cross-site study of methane uptake rates and the identity of methane oxidizing bacteria, led by Dr. Joe van Fischer (Colorado State University)

Konza LTER scientists are also involved in a variety of international collaborative efforts. For example, Konza LTER scientists and scientists from South Africa are conducting collaborative studies of ecological responses to fire and grazing in North American and Southern African grasslands [J. Blair (KSU), M. Smith (Yale), Alan Knapp (CSU), Scott Collins (UNM) and collaborators in South Africa (Kevin Kirkman and Richard Fynn at the University of KwaZulu-Natal, Pietermarizburg)]. Konza co-PI David Hartnett maintains collaborations with colleagues in Botswana, and has supported exchanges of graduate students there. In 2008, Hartnett re-visited field sites in Botswana with another LTER scientist (Gail Wilson) and LTER graduate student Jacqueline Ott to conduct research on bud bank ecology and the regulation of dynamics of southern African grasslands. In addition, Hartnett and Joern are Co-Directors of the Institute for Grassland Studies at KSU, which promotes international collaborative research on grassland ecology, and in 2009 Hartnett led a field class on a trip to South Africa and Botswana. In 2010, Konza LTER scientists participated in hosting a visit from a delegation from the University of Limpopo, South Africa. Also, in 2010, LTER co-PI Jesse Nippert received an international supplement to support his developing studies of woody plant encroachment into grasslands in South Africa. In 2009, Konza LTER scientist Brett Sandercock continued a collaborative study (funded by an LTER international supplement) with scientists in Uruguay to assess population dynamics of a migratory grassland bird (the Upland Sandpiper) in its northern and southern hemisphere ranges.Konza LTER scientist Samantha Wisely is working with students in Paraguay on wildlife conservation issues. In 2009, Konza Prairie LTER Scientists were invited to China to consult on grassland and herbivore studies (Joern) and to participate in an international conference (Blair and Knapp) organized by the Chinese Academy of Sciences. This resulted in separate research visits to the Konza LTER site by multiple Chinese scientists in 2010, including Dr. Shuguang Hao (Chinese Academy of Sciences), Dr. Yingzhi Gao (Northeast Normal University), Dr. Nianpeng He (Director, Inner Mongolian Grasslands Ecosystem Research Station), and Dr. Xin Xiaoping (Director, Hulunber Grassland Observation and Research Station). These visits typically included presentations of ongoing research in China, and discussions regarding potential future collaborations. In 2010, LTER co-PI Dodds hosted a visitor from Denmark (Dr. Tenna Riis, Aarhus University) to demonstrate stable isotope methods for studying stream N cycling at Konza. This resulted in a return visit by Dr. Dodds in the summer of 2010 to conduct collaborative research in Denmark.

In addition to the activities indicated above, Konza Prairie continues to host numerous visits by international scientists and students, including: Dr. Marjan Jongen of the Instituto Superior de Agronomia, Lisbon, Portugal; Matilde Alfaro-Barrios of Averaves-Investigaci?n y Conservaci?n, Uruguay; Rosa Roca, Servicio Regional de Investigaci?n y Desarrollo Agroalimentario, Spain. The Konza LTER program also provides on-site research opportunities (as well as logistic and/or financial support) for graduate students and post-doctoral scholars from a number of international venues (e.g., in 2008: Elske Koppenaal, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, South Africa. In 2009-11: Nicole Hagenah, University of KwaZulu-Natal, South Africa. In 2011: Akalak Kunsorn, visiting PhD student from the University of Chiang-Mai, Thailand.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

see attached pdf

Findings: (See PDF version submitted by PI at the end of the report)
see attached pdf

Training and Development:
The Konza Prairie LTER program provides educational and training activities for students, developing scientists, and the general public at a wide range of levels, from the education of K-12 students to the training of undergraduate/graduate students and post-doctoral scientists. Konza LTER data and findings are used widely in texts and web-based educational sites. In addition, through our Schoolyard LTER program and targeted KSU programs (e.g., Girls Researching Our World (GROW), GK-12 (Evidence-Based Inquiry into the Distant, Remote or Past) and the Howard Hughes-sponsored KSU Science Teachers Training program) we provide opportunities for high school and junior high school teachers to work with, and learn from, Konza LTER scientists.

Contributions to K-12 Education:

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 13th year as an science education program for K-12 teachers and their students, built around the successful Konza Prairie LTER program. Our SLTER program is directed by the Konza Environmental Education Program Director (Dr. Valerie Wright) 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 with input from researchers and teachers, to give students an understanding of ecology and to provide them the opportunity to collect and interpret their own data, which can be integrated with our long-term student-collected SLTER databases via the Internet (see http://keep.konza.ksu.edu). By sharing knowledge generated through long-term data collection at the Konza Prairie LTER site and adding information from student data collections, we give teachers tools for connecting children to locally and regionally important ecosystems.

In addition to site-based activities, the Konza Prairie SLTER program has been expanded to include enhanced science education opportunities for students and teachers in schools across Kansas. As SLTER activities at Konza Prairie approached maximum capacity for the site, we sought and obtained funding (EdEn 2004 & 2005) to expand our SLTER program to reach school districts beyond our local area with an SLTER program called Prairies Across Kansas (PAK). Most of these districts include a high percentage of rural families and have far less access to good local or regional science resources. The teachers are trained at Konza Prairie in a workshop similar to those offered to local teachers. With training and support from the SLTER program, these teachers and their students participate in data collection at native prairie sites near their home schools. As non-local teachers are recruited for the workshop, we help them locate appropriate native prairie sites near their schools. This allows direct comparison of ecological processes, and change over time, in different regional prairie types (tall-, mixed- and short-grass prairies) through SLTER databases, because all teachers in the program follow the same protocols. In order to enhance regional coverage and participation in the PAK program, we have targeted school districts in the mixed and shortgrass regions of Kansas, by providing printed information on the SLTER and PAK programs and specific invitations for teachers to join the project. The website materials are promoted among all Kansas teachers through announcements and presentations at conferences and state-wide meetings each year. In total, the Konza Environmental Education Program (KEEP), the SLTER program, and the recent addition of Prairies Across Kansas educate local and statewide teachers and their students about the unique attributes of prairie ecosystems and important global changes which impact the central US grasslands.
The KNZ SLTER program continues to grow in terms of participating teachers and numbers of students reached. As an example of recent activities, in 2010 82 teachers brought classes to KNZ, including 35 classes that annually participate in SLTER science activities as part of their regular teaching activities. Twelve of these SLTER teachers are from a nearby school district, which has 55% economically disadvantaged students. These teachers brought an additional 14 teachers to KNZ with their students as an introduction to our SLTER program. In 2010, a total of 982 students from 18 schools participated in 34 hands-on activities at Konza Prairie. In addition to students participating in site-based SLTER activities, the Prairies Across Kansas program impacted an additional 366 students across the state for a total of 1348 students. Since 1999 we estimate that we have reached > 12,000 students from 3rd grade through high school with SLTER activities at Konza Prairie and another 2400 across the state through PAK. With continued SLTER support in 2011, we anticipate involving ~1000 additional students in activities at Konza, with a number similar to 2010 from around the state participating in PAK activities. 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.

The Konza Prairie LTER site is also used as part of the KSU Girls Researching Our World (GROW) Program. This program, funded by the NSF Gender Equity in SMET initiative, provides 6th-8th grade girls with exposure to careers science using environmental stewardship as a theme (www.ksu.edu/grow/). Most recently, KSU was awarded a GK-12 grant to pair graduate students with local high school teachers in a unique science education-focused program - Evidence-Based Inquiry into the Distant, Remote or Past (EIDRoP). During the 2009-10 academic year, two Konza LTER graduate students participated in the GK-12 program through classroom activities in the Junction City High School, and both incorporated aspects of the Konza Prairie LTER program into their GK-12 projects.

Contributions to Undergraduate and Graduate Education:

At the college undergraduate and graduate level, Konza Prairie continues to serve as an outdoor laboratory for classes and visiting field courses from numerous educational institutions and LTER research dominates the curriculum. The Konza Prairie LTER program has a strong record of providing training opportunities for undergraduates via employment of research assistants (approximately 25 undergraduate students are supported with LTER funding each year) and through NSF REU supplements and an REU site grant based at Konza Prairie, which supports 8-10 undergraduates per year from institutions throughout the U.S. Summer 2011 was the 16th 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 an NSF-funded URM program. REU students were recruited nationwide and primarily from undergraduate institutions with limited opportunities for research: Grinnell College (IA), Missouri State University (MO), Saint Joseph's University (PA), Skidmore College (NY), Swarthmore College (PA), University of Dallas (TX), University of Illinois at Urbana-Champaign (IL), University of Michigan at Ann Arbor (MI), University of Puerto Rico at Mayguez (PR), and University of Tennessee at Knoxville (TN). The URM program is a full year program and the URM students were recruited from K-State. The 17 REU/URM students included 10 women and 3 underrepresented minority students. All students were matched with a research mentor and provided with opportunities for independent research. Our REU program targets recruitment of underrepresented groups to the extent possible. In 2009, one of our former REU students (Jorge Mendoza, REU in 2008) was a participant in KSU Developing Scholars Program, which pairs underrepresented students with faculty mentors for research projects. Konza LTER investigator Brett Sandercock served as his mentor. A news release about his research experiences is available at www.k-state.edu/media/newsreleases/jan09/mendoza11309.html. In 2001, Konza undergraduate student researcher Graciela Orozco (mentored by LTER co-PI Jesse Nippert) was selected for KSU's McNair Scholars program, which prepares underrepresented and first generation students for successful careers as graduate students, professors and professional researchers (www.k-state.edu/media/newsreleases/feb11/labtechs21511.html).

Konza LTER data are used in an increasing 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, findings of Konza Prairie LTER studies are increasingly utilized in undergraduate ecology texts and supplementary teaching materials. For example, Konza Prairie LTER 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 Konza 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. Konza 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). Konza data are used 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). Konza LTER 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:

Nippert, J.B., and J.M. Blair. 2005. Comparing the influence of precipitation, fire, and topography on plant productivity in the tallgrass prairie. Teaching Issues and Experiments in Ecology, Vol. 3: Issues: Data Set #1 tiee.ecoed.net/vol/v3/issues/data_sets/konza/abstract.html

Dalgleish, H.J. and T.M. Woods. 2007. The effects of bison grazing on plant diversity in a tallgrass prairie (Konza Prairie LTER). Teaching Issues and Experiments in Ecology, Vol. 5: Practice #1. tiee.ecoed.net/vol/v5/practice/dalgleish/abstract.html

Johnson, N.C., V.B. Chaudhary, J.D. Hoeksema, J.M. Moore, A. Pringle, J.A. Umbanhowar, and G.W.T. Wilson. 2009. Mysterious mycorrhizae? A field trip and classroom experiment to demystify the symbioses formed between plants and fungi. American Biology Teacher 71: 424-429.

The Konza LTER program continues to provide training for numerous graduate students at Kansas State University, and has become an important resource for training students from a number of other institutions including the University of Colorado, University of Kansas, University of Kentucky, University of New Mexico, Southern Illinois University, Colorado State University, Cornell University, and Yale University. Currently, approximately 20 graduate students are currently supported, in full or in part, with Konza LTER resources. Several of these students, from KSU and from other institutions, are currently using the Konza LTER site in cross-site or regional studies, some of which involve other LTER sites or international partners. For example, students from KSU and CSU are participating in cross site studies involving

the KNZ and SGS LTER sites. During the previous LTER funding cycle (2002-2008), 60 student theses and dissertations were supported by the Konza Prairie LTER program. Below, we begin a new listing of theses and dissertations completed during LTER VI (2009-2014):

2009

An, N. 2009. Estimating annual net primary productivity of the tallgrass prairie ecosystem of the Central Great Plains using AVHRR NDVI. MS Thesis, University of Kansas. Lawrence, Kansas.

Bach, E.M. 2009. Biotic and abiotic drivers of soil microbial community recovery and ecosystem change during grasslands restoration. MS Thesis, Southern Illinois University. Carbondale, IL.

Bowe, S.E. 2009. The influence of host ecology and land cover change on rabies virus epidemiology in the Flint Hills. MS Thesis, Kansas State University. Manhattan, KS.

Buis, G. 2009. Controls of aboveground net primary production in mesic savanna grasslands: An inter-hemispheric comparison. MS Thesis, Colorado State University. Fort Collins, CO. 50 pp

Campbell, R.E. 2009. Variation in benefit from arbuscular mycorrhizal fungal colonization within cultivars and non-cultivars of Andropogon gerardii and Sorghastrum nutans. MS Thesis, Southern Illinois University. Carbondale, IL. 97 pp

Grace, T. 2009. Host associated genetic divergence and sexual isolation in the grasshopper Hesperotettix viridis (Orthoptera: Acrididae). PhD Dissertation, Kansas State University. Manhattan, KS. 127 pp

Klug, P.E. 2009. Interactions between grassland birds and their snake predators: the potential for conservation conflicts in the tallgrass prairie. PhD dissertation, Kansas State University. Manhattan, KS. 126 pp

Ott, J. 2009. Bud bank morphology, dynamics, and production in perennial grasses. MS Thesis, Kansas State University. Manhattan, KS. 93 pp

2010

Buck, T. 2010. The impact of land cover change on water and carbon cycling in the US central plains grasslands. MS Thesis, University of Kansas. Lawrence, KS.

Commerford, J.L. 2010. Calibrating vegetation cover and pollen assemblages in the Flint Hills of Kansas, USA. MA Thesis, Kansas State University. Manhattan, KS. 73 pp.

Lohnes, R.G. 2010. Nest site selection and nest thermal properties of common nighthawks on the tallgrass prairie of Kansas. MS Thesis, Cornell University. Ithaca, NY.

McNew, L.B. 2010. An analysis of Greater Prairie-chicken demography in Kansas: the effects of human land use on the population ecology of an obligate grassland species. PhD Dissertation, Kansas State University. Manhattan, KS. 149 pp.

Petrie, M. 2010. Climate forcings and the nonlinear dynamics of grassland ecosystems. MA Thesis, University of Kansas. Lawrence, KS.

Reisinger, A.J. 2010. Factors affecting denitrification in headwater prairie streams. MS Thesis, Kansas State University. Manhattan, KS.

Sprinkle, J.W. 2010. Bud bank density regulates invasion by exotic plants. MS Thesis, Oklahoma State University. Stillwater, OK. 65 pp.

Tucker, S. 2010. Morphological and physiological traits as indicators of drought tolerance in tallgrass prairie plants. MS Thesis, Kansas State University. Manhattan, KS.

Whiting, D.P. 2010. Macroinvertebrate production, trophic structure, and energy flow along a tallgrass prairie stream continuum. MS Thesis, Southern Illinois University. Carbondale, IL.

Williamson, M.M. 2010. Controls on bud activation and tiller initiation in tallgrass prairie: The effect of light and nitrogen. MS Thesis, Oklahoma State University. Stillwater, OK. 52 pp

Winders, K. 2010. Ecosystem Processes of Prairie Streams and the Impact of Anthropogenic Alteration on Stream Ecological Integrity. MS Thesis, Kansas State University. Manhattan, KS.

2011

Gregory, A.J. 2011. The influence of behavioral and landscape ecology on Greater Prairie-Chicken (Tympanuchus cupido) genetic structure and evolution. PhD, Kansas State University. Manhattan, KS. 129 pp

Hartman, J. 2011. Responses of switchgrass (Panicum virgatum L.) to precipitation amount and temperature. MS Thesis, Kansas State University. Manhattan, KS.

Mohler, R. 2011. Multi-scale burned area mapping in tallgrass prairie using in situ spectrometry and satellite imagery. PhD Dissertation, Kansas State University. Manhattan, KS.

Riley, A.J. 2011. Effects of riparian woody vegetation encroachment on prairie stream structure and function with emphasis on whole-stream metabolism. PhD Dissertation, Kansas State University. Manhattan, KS.

Rostkowski, S.C., Jr. 2011. Long-term effects of climate change on grassland soil systems: A reciprocal transplant approach. MS Thesis, Kansas State University. Manhattan, KS. 80 pp.

Tiemann, L. 2011. Soil microbial community carbon and nitrogen dynamics with altered precipitation regimes and substrate availability. PhD Dissertation, University of Kansas. Lawrence, KS.

Outreach Activities:

Konza Prairie LTER data and findings are used to support numerous outreach activities at local, regional, national and international levels. At a local level, Konza scientists regularly participate in Kansas Agricultural Experiment Station (KAES) extension and public education events (including on-site tours of LTER research areas for local ranchers and conservationists, and presentations of LTER research findings relevant to grassland management and conservation), and host a biennial Visitors' Day at the Konza Prairie site (the most recent visitor's day was September 27, 2010). The Konza Prairie LTER site also supports a 10 km nature trail system open to the public daily, and a trained docent program for group tours of the site. The trail system includes numbered stations with accompanying trail guide describing the history and ecology of Flint Hills tallgrass prairie.

At the regional level, Konza Prairie hosts frequent field tours of LTER research sites for groups such as The Nature Conservancy, the Flint Hills Alliance, the EPA Region 7 field office, and state of Kansas congressional representatives. In the current LTER VI funding period, this included visits by the Midwestern Science Coordinator for The Nature Conservancy, the Kansas Chapter of The Nature Conservancy, meetings of the Kansas Cooperative Fish and Wildlife Service, the Kansas Department of Wildlife and Parks, USDA Natural Resources Conservation Service personnel, and the Great Plains Plant Systematics Symposium. Konza LTER scientists communicate research results through regular presentations to regional farming, ranching and conservations groups including the Tallgrass Legacy Alliance, Kansas Society for Range Management, and the Kansas Livestock Association. We also present information relevant to regional air and water quality issues. For example, in recent years we presented findings from Konza LTER fire studies to scientists and staff from the EPA Region 7 Office and the Kansas Department of Health and Environment in response to questions about the use of grassland fires in the management and conservation of grasslands. This is becoming an increasingly important issue as concerns grow about the potential adverse effects of grasslands fires on air quality in the Midwest, and there is a need to balance these concerns against an understanding of the importance of fire in the preservation of grassland ecosystems and rangeland resources. In 2008, Konza Prairie LTER research on climate change was featured in a Kansas City Star series on the potential impacts of climate change in Kansas. Konza LTER scientists also contributed publications and presentations geared toward the public through the Kansas Agricultural Experiment Station (KAES) and other regional agencies and organizations. Konza scientists continue to serve on the planning committee for the Flint Hills Regional Interpretive Center, using data from the Konza LTER program to inform decisions about the natural history and management of the Flint Hills region. In addition, results from the Konza LTER program have been used in developing ecosystem management and conservation strategies for Nature Conservancy preserves throughout the region. Konza scientist have published numerous articles on application of ecological research to achieve management goals in outlets such as the Journal of Range Management, Restoration Ecology, and Ecological Applications, and have hosted field tours for applied scientists, such as those with the Natural Resources Conservation Service. Finally, the Konza Environmental Education Program has partnered with K-State Libraries and several regional public libraries to bring a collection of over 200 titles and computer-based information on grassland ecology to several regional libraries on a three-month rotating basis. The first two of these were in public libraries in Council Grove and Junction City, Kansas.

At a national level, Konza scientists have served as advisors for a Smithsonian Museum of Natural History exhibit on grasslands and

agriculture (Forces of Change), as well as a traveling museum exhibit (Listening to the Prairie). In 2007 Konza Prairie was included in special feature in the April issue of the National Geographic magazine, which explored the tallgrass prairie ecosystem. In 2008, Konza was featured in an educational photographic exhibit at the Department of Interior museum in Washington, D.C., and in 2009 LTER scientists (Blair and Hartnett) were advisors for the developing Museum of Prairiefire, which will provide an interpretive educational focus on grassland ecology, and will partner with the American Museum of Natural History to bring AMNH traveling exhibits to the Kansas City area. In 2008, we hosted the EPA's newly formed National Agricultural Advisory Committee on a tour that featured LTER research. In 2010, we provided research oriented tours and presentations for the Natural and Environmental Resources Committee of the Kansas Farm Bureau, and for US congressional representative Jerry Moran. In 2011, Konza LTER scientists participated in a Soil Institute field training activity for USDA NRCS scientists.

The dissemination of information from the Konza LTER program to the general public has been facilitated by several nationally televised educational productions, including 'Where the Sky Began' (first aired on The Discovery Channel in 1998). Konza Prairie was also the central focus of a major educational documentary film on the history and ecology of the tallgrass prairie ('Last Stand of the Tallgrass Prairie'), which first aired nationally on PBS in April 2001. Both films continue to be broadcast at various dates around the country. In 2009, LTER scientists Towne and Nippert were interviewed at the Konza site by a production crew from NHK (Japan Public Broadcasting) as they filmed a television documentary featuring the native grasslands, indigenous peoples, wild horses and bison of the Great Plains. LTER scientists provided commentary on the ecology of Great Plains grasslands and bison for the program, which aired on NHK Public Broadcasting in Japan in April 2009. Also in 2009, LTER scientists Briggs and Blair were interviewed at the Konza site as part of a documentary project on global change ecology and environmental issues in the Great Plains (http://ecoheartland.com/). This film was featured at the 2009 Tallgrass Film Festival in Wichita, Kansas. The importance of long-term ecological research and climate change experiments were highlighted in the film. Highlights of recent scientific findings from the Konza LTER program have also been featured on national media outlets (e.g., the DiscoveryChannel.com).

Program development and activities of the Konza Prairie Environmental Education Program (KEEP) continued during 2008-2011. The goals of KEEP are to promote increased understanding and appreciation of the tallgrass prairie ecosystem and the importance of ecological research as a foundation for sound grassland conservation and management. Konza LTER researchers and results provide direct input to the education program, and provide training for Konza Prairie docents. Konza LTER research results have been summarized in training materials and curricula for docents and K-12 teachers, and Konza LTER researchers have participated directly in teacher training during the Konza Schoolyard LTER workshops. The KEEP program features directed tours and on-site educational programs for K-12 classes and teachers, adult education programs led by researchers and trained docents, as well as Schoolyard LTER programs and teacher training workshops. In addition to these formal programs, a 10 km nature trail system on Konza Prairie is open to the public daily and provides numbered stations with an accompanying trail guide describing many aspects of the history and ecology of the Flint Hills tallgrass prairie. Approximately 3000 to 4000 visitors use the self-guided trails annually. Another important public education and outreach activity is the biennial Konza Prairie Visitors' Day ? an open house featuring tours of the LTER research areas and experimental plots by LTER scientists, guided tours of the fire and grazing (bison and cattle) research units, and numerous ecological research and natural history displays.

Journal Publications

Baer, S.G., D. Engle, J.M.H. Knops, K.A. Langeland, B.D. Maxwell, F.D. Menalled, and A. Symstad, "Non-target and invasive species in rehabilitated production systems: Ecological impacts, management and future use.", Environmental Management, p. , vol. , (2009). Accepted,

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Craine, J.M., E.G. Towne, A. Joern and R.G. Hamilton., "Consequences of climate variability for the performance of bison in tallgrass prairie.", Global Change Biology, p. 772, vol. 15, (2009). Published,

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Bibliography: MA Thesis, Kansas State University, Manhattan, KS. 73 pp

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Bibliography: PhD Dissertation, Kansas State University, Manhattan, KS. 149 pp

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Bibliography: MS Thesis, Kansas State University, Manhattan, KS.

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Bibliography: M.S. Thesis, Kansas State University, Manhattan, KS. 65 pp

Sprinkle, J.W., "Bud bank density regulates invasion by exotic plants", (2010). Thesis, Published
Bibliography: M.S. Thesis, Oklahoma State University, Stillwater, KS. 65 pp

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Bibliography: Ph.D., Kansas State University. Manhattan, KS

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Bibliography: Ph.D., Kansas State University. Manhattan, KS

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Bibliography: MS Thesis, Kansas State University, Manhattan, KS

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Collection: Advances in Stream Fish Community Ecology: Concepts, Approaches and Techniques
Bibliography: American Fisheries Society, Symposium 73. Bethesda, Maryland. pp 593-617

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Editor(s): D. Wall, D. Strong, V. Behan-Pelletier
Collection: Oxford Handbook of Soil Ecology and Ecosystem Services
Bibliography: Oxford University Press

Web/Internet Site

URL(s):

http://www.konza.ksu.edu/
http://kpbs.konza.ksu.edu

Description:

The first URL is for the main website for the Konza Prairie LTER program. It is used to disseminate general information about the KNZ LTER program, and is a portal for accessing Konza LTER data and publications.

The second URL is for the Konza Prairie Biological Station.

Other Specific Products

Product Type:

Physical collection (samples, etc.)

Product Description:

The Konza Prairie LTER program includes an extensive collection of physical samples (plants, soil, invertebrates, water samples, etc.), which are archived for future analyses or use by LTER or other researchers.

Sharing Information:

Physical samples archived by the Konza LTER program are available upon request to other researchers.

Contributions

Contributions within Discipline:

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 2010-2011 (the current reporting period), the KNZ program produced or contributed to 110 publications: 91 refereed journal articles (including 17 currently in press), 2 book chapters, and 17 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, including:

Beaulieu, J.K., J.L. Tank, S.K. Hamilton, W.M. Wollheim, R.O. Hall Jr., P.J. Mulholland, B.J. Peterson, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, W.K. Dodds, N.B. Grimm, S.L. Johnson, W.H. McDowell, G.C. Poole, H.M. Valett, C.P. Arango, M.J. Bernot, A.J. Burgin, C. Crenshaw, A.M. Helton, L. Johnson, J.M. O'Brien, J.D. Potter, R.W. Sheibley, D.J. Sobota, and S.M. Thomas. 2011. Nitrous oxide emission from denitrification in stream and river networks. Proceedings of the National Academy of Sciences of the United States of America 108: 214-219.

Buis, G.M., J.M. Blair, D.E. Burkepile, C.E. Burns, A.J. Chamerlain, P. Chapman, S.L. Collins, R.W.S. Fynn, N. Govender, K. Kirkman, M.D. Smith and A.K. Knapp (In Press) Controls of aboveground net primary production in mesic grasslands and savannas: An interhemispheric comparison. Ecosystems.

Findlay, S., P. Mulholland, S. Hamilton, J. Tank, M. Bernot, A. Burgin, C. Crenshaw, W. Dodds, N. Grimm, W. McDowell, J. Potter, and D.

Sobota. 2011. Cross-stream comparison of substrate-specific denitrification potential. Biogeochemistry 104: 381-392.

Garrett, K.A., G.A. Forbes, S. Savary, P. Skelsey, A.H. Sparks, C. Valdivia, A.H.C. van Bruggen, L. Willocquet, A. Djurle, E. Duveiller, H. Eckersten, S. Pande, C. Vera Cruz, and J. Yuen. 2011. Complexity in climate change impacts: An analytical framework for effects mediated by plant disease. Plant Pathology 60: 15-30.

Heisler-White, J.L., J.M. Blair, E.F. Kelly, K. Harmoney, and A.K. Knapp. 2009. Contingent productivity responses to more extreme rainfall regimes across a grassland biome. Global Change Biology 15: 2894-2904.

Harmon, M.E., W.L. Silver, B. Fasth, H. Chen, I.C. Burke, W.J. Parton, S.C. Hart, W.S. Currie and LIDET. 2009. Long-term patterns of mass loss during the decomposition of leaf and fine root litter: an intersite comparison. Global Change Biology 15:1339-1355.

Johnson, N.C., G.W.T. Wilson, M.A. Bowker, J.A. Wilson, and R.M. Miller. 2010. Resource limitation is a driver of local adaptation in mycorrhizal symbioses. Proceedings of the National Academy of Sciences of the United States of America 107: 2093-2098.

Mulholland, P.J., A.M. Helton, G.C. Poole, R.O. Hall, Jr., S.K. Hamilton, B.J. Peterson, J.L. Tank, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, W.K. Dodds, S. Findlay, S.V. Gregory, N.B. Grimm, S.L. Johnson, W.H. McDowell, J.L. Meyer, H.M. Valett, J.R. Webster, C. Arango, J.J. Beaulieu, M.J. Bernot, A.J. Burgin, C. Crenshaw, L. Johnson, B.R. Niederlehner, J.M. O'Brien, J.D. Potter, R.W. Sheibley, D.J. Sobota, and S.M. Thomas. 2008. Excess nitrate from agricultural and urban areas reduces denitrification efficiency in streams. Nature 452: 202-207.

Cleland, E.E., C.M. Clark, S.L. Collins, J.E. Fargione, L. Gough, K.L. Gross, S.C. Pennings, W.D. Bowman, G.P. Robertson, J. Simpson, D. Tilman and K.N. Suding. 2008. Species responses to nitrogen fertilization in North American plant communities, and associated species traits. Ecology (Ecological Archives) 89: 1175.

Knapp, A.K., C. Beier, D.D. Briske, A.T. Classen, Y. Luo, M. Reichstein, M.D. Smith, S.D. Smith, J.E. Bell, P.A. Fay, J.L. Heisler, S.W Leavitt, R. Sherry, B. Smith and E. Weng. 2008. Consequences of more extreme precipitation regimes for terrestrial ecosystems. BioScience 58:811-821.

Dodds, W.K., K.C. Wilson, R.L. Rehmeier, G.L. Knight, S. Wiggam, J.A. Falke, H.J. Dalgleish, and K.N. Bertrand. 2008. Comparing ecosystem goods and services provided by restored and native lands. BioScience 58:837-845.

Spasojevic, M.J., R.J.Aicher, G.R. Koch, E.S. Marquardt, N. Mirotchnick, T.G. Troxler, and S.L. Collins. 2010. Fire and grazing in a mesic tallgrass prairie: impacts on plant species and functional traits. Ecology 91: 1651-1659.

Smith, M.D., A.K. Knapp, and S.L. Collins. 2009. A framework for assessing ecosystem dynamics in response to chronic resource alterations induced by global change. Ecology 90: 3279-3289.

Another metric of the contributions of the Konza LTER program to ecology is the ability to leverage additional non-LTER funds to support Konza-related ecological research. Our success at securing additional funding from a variety of sources has substantially broadened our research base, and allowed us to greatly expand the scope of Konza LTER-related studies. During the current reporting period (2010-2011), approx. $14M in active awards (in addition to LTER funding) contributed to ecological research and training activities at Konza (see Research Activities for a list of KSU-based active funded projects). Finally, with the start of the LTER VI grant we are supporting the participation of several new investigators (Nathaniel Brunsell - Geography/Atmospheric Sciences, University of Kansas; Kendra McLauchlin - Geography KSU; K.C. Olson - Animal Sciences, KSU; Gail Wilson - Oklahoma State University), resulting in additional diversification of our research program.

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 (Baer and Blair 2008, Baer et al. 2010, in press, Heneghan et al. 2008);

valuation of ecosystem services in native and restored ecosystems (Dodds et al. 2008);

a novel framework for ecological responses to chronic resource alterations (Smith et al. 2010);

generalized plant community responses to chronic N enrichment (Cleland et al. 2008, Chalcraft et al. 2008);

the role of landscape fragmentation in the spread of pests and disease (Margosian et al. 2009);

factors controlling nitrate retention and removal in a range of stream ecosystems (Hall et al 2009, Mulholland et al. 2009);

the role of unique nutritional niches in the coexistence of generalist insect herbivores (Loaiza et al. 2008, Behmer and Joern 2008);

the extent and limits of ecological generalities derived from one geographic locale to other regions with different evolutionary histories (Swemmer et al. 2007, Buis et al. 2009).

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 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 land-use and land-cover change (Kitchen et al. 2009, Knapp et al. 2008, McKinley et al. 2008.

As we begin the LTER VI funding cycle, the Konza Prairie LTER program continues to expand its involvement in ecological synthesis activities by contributing to, and in many cases leading, regional and network-level science activities. For example, Konza LTER scientists Blair and Knapp led a working group on climate change in terrestrial ecosystems at the 2009 Science Council meeting, with a follow-up meeting to take place at the 2009 ASM. Doug Goodin is a long-time member of the LTER Climate Committee. John Harrington and KSU Geography students (Judd Patterson and Tom Prebyl) participated in four recent LTER Network-sponsored workshops on integration of social and ecological sciences (at LUQ), ecosystem services and working lands (at KBS and the 2008 Science Council meeting), scenarios of future landscape change (at HFR), and an LTER supplement-funded cross-site site study of socioeconomic drivers and patterns of land-use and land-cover change (at CAP). Blair, Knapp and Smith have been regular participants in LTER planning for future LTER research priorities (the ISSE initiative), and several Konza scientists have had an active role in the EcoTrends project. Konza LTER scientists and students are participants in the Nutrient Network (NutNet) Global Research Cooperative (locally led by M. Smith). A new initiative to link ecological and health-related disciplines to address the ecology of diseases is being spearheaded by Konza scientist Samantha Wisely.
An example of a recent cross-disciplinary and cross-site project is: Socioecological Gradients and Land-Use Fragmentation: A Cross-Site Comparative Analysis (CAP, JRN, KNZ, SEV, and SGS)

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 was co-convener of an NSF-sponsored US-Africa Workshop to enhance collaborative research on the environment in 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. With supplemental LTER funding, Brett Sandercock is collaborating with scientists in Uruguay on a migratory bird project. Finally, several Konza PIs (Knapp, Blair, Smith, Collins) were awarded new NSF funding to extend Konza LTER studies in a test of ecological generalities in South African grasslands (Collaborative Research: Convergence and Contingencies in Grassland Savannas).

Contributions to 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, Konza was used by atmospheric scientists from the University of California Berkeley (led by Rob Rhew) to assess fluxes of atmospheric methyl halides in temperate North American grassland ecosystems, employing a recently developed stable isotope tracer technique to separate simultaneous production and consumption fluxes. 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) is using 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. We collaborate with Gene Kelly (pedologist) and his students (Colorado State University) to assess patterns and controls of silica weathering and patterns of soil weathering and P availability in Great Plains grasslands. Another soil scientist from Cornell (Johannes Leahman) is using 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 (James Koelliker) has been a long-time 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 Konza LTER program has also contributed to recent research and synthesis activities in the area of Plant Pathology and Ecological Genomics.

In the last several years, we greatly expanded our interactions with social scientists, in both site-based and LTER network level activities. For example, we supported the activities of a faculty member (Gerrad Middendorf) and graduate student (Derick Cline) in the Department of Sociology at KSU. Dr. Middendorf was also a participant in the multi-site Agrarian Ecosystems in Transition project (Middendorf, G., D. Cline, and L. Bloomquist, 2008. Agrarian Landscape Transition in the Flint Hills of Kansas: Legacies and Resilience. Page 206-237. In Charles Redman and David Foster (eds.) Agrarian Landscapes in Transition: Comparisons of Long Term Ecological & Cultural Change. Oxford University Press. New York.) We also support and collaborate with Senior Investigators in the Department of Geography (Doug Goodin, John Harrington, Kendra McLauchlan and Kevin Price). John Harrington is a co-investigator for the LTER Network-sponsored workshops on ecosystem services in working lands, and a contributor to the broader LNO ecosystem services group led by Terry Chapin and others. Dr. Harrington also represented Konza Prairie in a recently funded cross-site initiative to assess drivers of land-cover change at multiple LTER sites. Geography graduate student Beau Burkitt was supported for cross-site hydrological modeling of future land cover scenarios using SWAT [with Ken Sylvester from SGS and funding from the Agrarian Transitions project). Most recently, KSU hired a new faculty member in Geography with expertise on interactions of humans and the environment (Dr. Kendra McLauchlan), and has worked to incorporate her as appropriate into the Konza LTER program.

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.

Contributions to Human Resource Development:

The Konza Prairie LTER VI program makes significant contributions to human resource development in science, engineering and technology. Our program contributes 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 LTER VI funding period, the site has been used by graduate students from the University of Kansas, University of Colorado, University of Kentucky, University of New Mexico, University of Pittsburgh, University of California - Santa Barbara, Iowa State University, Southern Illinois University, Colorado State University, Cornell University, Yale University, and several others. We also hosted field trips for students from many regional colleges and universities, such as Principia College, Concordia College, University of Minnesota-Mankato, Truman State University, Pittsburgh State University, the University of Colorado, and others.

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 is being used by local high school teachers to develop educational activities as part of Howard Hughes funded teacher training program. In 2008-09, Blair served as consultant for a local high school teacher (Drew Ising), who is establishing a prairie restoration research site, and developing a class module on soils, for his course in Environmental Biology and Ecology at Junction City High School. The Konza LTER program also provides research support for a GK12-sponsored graduate student working with this high school teacher. 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.

Contributions to Resources for Research and Education:

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 new 2-bedroom housing units expand the accommodation capacity to 25 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 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. Climate controlled greenhouse space is available on the KSU campus. In addition, other 'typical' laboratory equipment (balances, microscopes, etc.) is available in individual investigator laboratories.

Contributions Beyond Science and Engineering:

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 scientists also participated in the development of a management and monitoring plan for the Tallgrass Prairie National Preserve, and a training workshop in tallgrass prairie ecology and management for the NPS Rangers at the National Preserve. In 2008, Konza Prairie hosted a field trip for scientists from the Natural Resources Conservation Service. Konza LTER scientists also serve on the planning committee for the Flint Hills Regional Interpretive Center. At a national level, Konza Prairie hosted a delegation of 15 U.S. Congressional Assistants, which highlighted results from the Konza LTER program as an example of the value of long-term ecological studies for the long-term sustainable management of natural resources. Konza scientists have also served as advisors for a Smithsonian Museum of Natural History exhibit on grasslands and agriculture (Forces of Change), as well as a traveling museum exhibit (Listening to the Prairie). In 2008, Konza Prairie was the focus of a photographic exhibit at the Department of Interior Museum in Washington, D.C. 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 produces limited edition hand-colored photographs and lithographs of Konza landscapes (www.prairielight.com), and a photographic exhibit of Konza Prairie by nature photographer Judd Patterson (www.juddpatterson.com)was featured at a recent exhibit (A Sea of Tallgrass: the Konza Prairie) at the Department of Interior in Washington, DC. Most recently, the Konza Prairie Biological Station has provided on-site housing for a Visiting Writers series, in conjunction with the KSU English Department. Writers in Residence have included Moya Cannon (2010) and John Price (2011).

Conference Proceedings

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Conference

Background on the Konza Prairie LTER Program

The Konza Prairie LTER Program is a comprehensive, interdisciplinary research program that contributes to synthetic ecological studies and conceptual and theoretical advances in the field of ecology, and provides a mechanistic and predictive understanding of ecological processes in mesic grasslands. The Konza Prairie LTER program also offers educational and training opportunities for students at all levels, provides outreach and public education 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.

Konza was one of 6 original LTER sites, and pre-LTER research extends selected datasets back >30 years. The focal site for our core LTER research is the Konza Prairie Biological Station, a 3487-ha area of native tallgrass prairie in the Flint Hills of northeastern Kansas. The KPBS was established in 1971, with land acquired by the Nature Conservancy and deeded to Kansas State University, and became a part of the LTER Network in 1981. With funding from the LTER program we amassed long-term datasets on processes such as hydrology, nutrient cycling, plant productivity and community composition, including many that now span more than 25 years. These long-term records provide unique insights into the dynamic nature of tallgrass prairie ecosystems, and increasingly serve as a critical baseline for identifying and interpreting ecological responses to a variety of global change pressures. The Konza LTER program encompasses studies at, and across, multiple ecological levels and a variety of spatial and temporal scales. The unifying conceptual framework guiding this research has been that fire, grazing and climatic variability are essential and interactive factors shaping the structure and function of mesic grassland ecosystems. The interplay of these natural disturbances across a heterogeneous landscape leads to the high species diversity and complex, non-linear behavior characteristic of these grassland ecosystems. Because grazing and fire regimes are managed in grasslands worldwide, Konza LTER data are relevant not only for understanding grasslands globally, but also 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 the key drivers of ecological processes in these grasslands, we are able to use Konza LTER 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, this long-term research 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 the grasslands of North America, and around the world.**

The Konza LTER program continues to build upon 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. This unique experimental design includes replicate watersheds subject to different fire and grazing treatments (Fig. 1), 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.

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 >70 long-term datasets in association with long-term experiments ongoing as part of this program, and many more research activities of planned shorter duration.

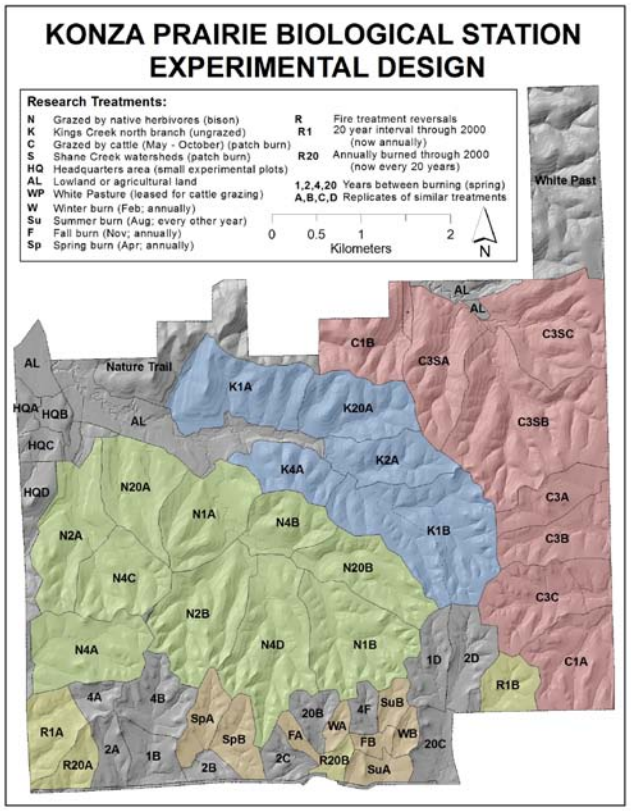


Figure. 1. Konza Prairie site experimental design, and watershed-level fire and grazing treatments. Watersheds with native ungulate (bison) grazing ('N') are light green, and cattle-grazed watersheds ('C') are red. All other watersheds are ungrazed. Numbers designate fire return intervals, and the last letter (A,B,C,D) identifies replicates of the same treatment. Watersheds subject to different seasons of burn (W=winter, F= fall, Sp= spring, SU=summer) are brown, and the Fire Treatment Reversal ('R') watersheds are yellow. Many plot-level experiments are located at the headquarters areas (HQ) in the northwest portion of the site.

We are presently in the third year (2010-2011) of our most recent LTER grant (LTER VI). Konza LTER VI (2008-2014) will continue to address fundamental ecological questions, but 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. We focus on long-term responses to facets of global change most relevant to grasslands and grassland streams – *changes in land-use* (fire and grazing regimes, grassland restoration) and *land-cover* (particularly increases in woody plant cover); *climate change and altered hydrology*; 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 will also address biotic interactions (competition, mutualism, predation, herbivory) in grasslands, and will continue to provide insight into a broad range of general ecological phenomena. In total, our goals for KNZ 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.

As to be expected in 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 are being initiated, as detailed in the original Konza 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. Space constraints prevent us from listing all LTER activities, but below we highlight a few selected activities from our most recent funding period.

Konza Prairie Research Activities (2010-2011):

Fire Ecology in Tallgrass Prairie.

In 2010-2011, we continued the long-term, watershed-level fire treatments, and associated data collection efforts, that have been central to our "core" long-term studies since the initiation of the Konza LTER program (Figs. 1 and 2). Specifically, we continued long-term experiments on the effects of different fire frequencies (1, 2, 4 and 20 year fire return intervals), as well as watershed-level treatments designed to determine the effects of seasonal timing of fires (spring, summer, autumn and winter). Watersheds with different long-term fire return intervals continue to be focal areas for plant and consumer sampling, and measurement of a suite of ecosystem parameters by both local LTER scientists and visiting researchers. For example, watersheds with different fire regimes are being used for studies of genetic plant population structure and community invasibility by graduate students from Yale, studies of methanotrophic bacterial communities by researchers from Colorado State University, studies of *Panicum virgatum* ecotypic variation and physiology by students from St. Joseph University, studies of bird population dynamics by graduate students from Cornell and the University of Kentucky, and for studies of climate change by graduate students from Colorado State University and the University of New Mexico. Researchers from Cornell University have also been sampling watersheds with different fire histories as part of a cross-site study of black C storage in soils. A novel study on the effects of fire and topographic position on the isotopic variation in a widespread plant species (*Cornus drumundii*) was continued in 2011 (the "isoscapes" study), and results were presented at the 2009 meeting of the American Geophysical Union, a 2011 meeting on "Roles of

Figure 2. View of a watershed-level prescribed fire at Konza Prairie. In the foreground is a mowed fireguard separating watersheds assigned to different long-term fire treatments.

Stable Isotopes in Water Cycle Research" in Keystone, CO, and at seminars at University of Sheffield, Colorado State University, and Oklahoma State University in 2011.

The "season-of-fire" experiments (assessing the ecological consequences of fires at different times of the year) have taken on added significance in recent years, as questions about the impact of regional grassland burning and EPA regulations regarding air quality and have focused on the ecological importance of burning. This problem is exacerbated by the narrow window during which management-related (cattle pasture) spring burning typically takes place in the Flint Hills. Our data suggests that management-related burning could be spread out in time without adverse effects on grassland productivity or species composition, and will a lessen impact on spring air quality in major metropolitan areas. Findings from the season of fire project have been published in applied ecology journals (Towne and Kemp 2003, 2008), presented at various management-related meetings (e.g., the 2009 Natural Areas Research Conference in Nashville, TN) and highlighted during on-site field presentations for groups such as the EPA Region 7, Kansas Department of Wildlife and Parks, USDA Natural Resources and Conservation Service, and the Natural and Environmental Resources Committee of the Kansas Farm Bureau. The role of LTER studies on fire will continue to grow in importance as the issue of managing fire and smoke in the Midwest grows. Another area of current LTER research with important management implications is the patch-burn grazing studied (information provided in the following section on the interactions of fire and grazing).

Assessing the Interactive Effects of Fire and Grazing in a Grassland Landscape.
Native ungulates were an important driver of ecological processes in tallgrass prairie, and bison were reintroduced to Konza Prairie between 1987 and 1992. The bison herd at is maintained in ten watersheds covering 1,012 hectares, and stocked at rate to remove approximately 25% of the ANPP on average. Bison grazing activity is dynamic, and individuals select grazing sites in a highly variable manner throughout the year, especially in response to fire, and with big differences among years. In 2010-11, we continued studies of bison grazing based on collars fitted with GPS units to quantify spatial and temporal movement patterns of the bison herd. These data is allowing us to document landscape-level patterns of activity, and to recognize gradients of potential grazing impact within and among watersheds, including interactions with different fire frequency treatments over the long term. Our goal is to develop a quantitative grid of bison use intensity, which will aid in assessing the impacts of bison on vegetation dynamics and ecosystem processes at Konza Prairie, and will provide supporting data for a wide variety of studies. The watershed-scale fire-grazing experimental design at Konza Prairie is also being used in a newly funded NSF project (Joern, Biggs and others, 2010-2013) to assess nitrogen-driven ecosystem feedbacks affecting the landscape-level distributions and foraging activity of bison and the resulting consequences for creating landscape-level heterogeneity, which drives responses by dominant insect grazers. The primary hypothesis is that the variable spatial distribution of foliar-N content at landscape scales in response to fire and grazing coupled to the physical structure of the habitat determines landscape use by bison, thereby increasing habitat heterogeneity of variable suitability for other important insect herbivores affecting ecosystem function.

Other recent bison studies included a retrospective analysis of the effects of growing season climate and annual variation in plant productivity on the performance and growth of bison. As part of this study, 14 years of data on individual bison weights at Konza were analyzed and compared to potential explanatory variables. Konza Prairie Biological Station also recently participated in a project with other TNC sites to evaluate the degree of introgression of cattle genes into their bison herds. Using DNA extracted from hair follicles taken from the base of the tail during roundup in 2006-2007, 408 individual bison were screened for the presence of cattle genes. Of these, 1 of 406

(0.2%) samples contained domestic cattle mtDNA, and domestic cattle alleles of nuclear-DNA were identified at 3 of 14 markers in 16 of 408 (3.9%) individuals. These results indicated that the Konza Prairie herd has relatively low levels of introgression of cattle genes, relative to all TNC herds screened.

The long-term fire and grazing treatments maintained by the Konza Prairie LTER program also contribute to the goals of a recently-renewed (2009-2012) NSF-funded project to assess the generality of ecological responses to fire and grazing in North American (Konza Prairie) and South African (Kruger National Park and the University of KwaZulu-Natal's Ukulinga research site) grasslands. These grasslands have very different geological and evolutionary histories as well as different diversities of mammalian herbivores. The NSF-funded "Savannah Convergence" project is being directed by Konza LTER scientists Smith, Knapp, Blair and Collins. The Konza LTER program provides supporting data on climate, soils, nutrient availability, and patterns of ANPP and plant community composition in response to different long-term fire regimes and the presence or absence of bison in North American grasslands. In turn, the NSF Savanna Convergence project provides novel data on the effects of allowing or excluding grazer activity in areas subject to different fire return intervals. Activities at Konza Prairie in 2010-11 included monitoring spatial and temporal patterns of grazer utilization of plots subjected to annual burning, four-year fire return intervals and long-term fire suppression, as well as assessing patterns of ANPP and changes in plant community composition in plots subject to grazing or from which grazers are excluded. We are currently analyzing data from moveable exclosures collected over the last two years to assess potential effects of grazing on ANPP at the study sites. In 2010-11, University of New Mexico graduate student Sally Koerner continued here NSF DDIG research at Konza Prairie and in Kruger National Park, South Africa. This research takes advantage of ongoing fire and grazing treatments at Konza Prairie, and adds new climate manipulations with partial rainout shelters to investigate the interactive effects of grazing, fire and climate on plant community structure in North American (Konza Prairie, KS) and South African (Kruger National Park) savanna grasslands.

Cattle Grazing and Habitat Heterogeneity at the Landscape Scale: Konza LTER Patch Burn Experiment

Long-term studies of the Konza LTER based on bison grazing activities indicate that fire-grazing interactions promote habitat heterogeneity in many ways and at many scales. These include plant species composition, primary production and vegetation structure, and redistribution of nutrients by large mammalian consumers. Because mammalian grazers graze most intensely in recently burned watersheds, a shifting mosaic pattern of habitat suitability is created at a multiple watershed level scale. In turn, abundances and distributions of consumers also respond to habitat changes resulting from fire-grazing interactions. To increase our understanding of the spatio-temporal dynamics of fire-grazing interactions, we initiated a new patch-burn grazing experiment as part of LTER VI. This entailed modifying our former watershed-level experimental design to include two new, large replicate grazing units, each encompassing a mosaic of three individual watershed units (patches) subject to asynchronous prescribed fire and variable fire histories. This experiment required substantial field preparation, and coordination with collaborators in the Department of Animal Sciences. The patch-burn project will expand our understanding of the role of fire-grazing interactions based on native bison grazing to domesticated cattle grazing, the dominant management activity of the greater Flint Hills tallgrass ecosystem, and will address effects of fire and cattle grazing on grassland terrestrial and stream dynamics, and the promotion of biodiversity.

Our overarching hypothesis is that increased habitat heterogeneity resulting from management activity will support increased biodiversity at all levels, while maintaining acceptable levels of cattle

productivity/ condition. Response variables include changes in plant biomass and species composition, soil resources, abundances and diversity of birds, small mammals, grasshoppers, and stream invertebrates, and changes in stream geomorphology and biogeochemistry (see *Stream Studies* section for further details).

The experiment is taking place across two areas of KPBS (Shane Creek and Southern Cattle Units), each treated with 3-year rotations of annual burning. In 2008-10, we established new watershed boundaries, erected fences around the new grazing units (see Fig 1), and established watering locations. Konza LTER scientists held numerous planning meetings with scientists from Animal Sciences at KSU, and representatives from The Nature Conservancy (there is great interest in the potential use of patch-burning grazing to promote conservation in areas managed for cattle production). The first phase of this project was initiated in summer of 2010, with the implementation of patch burning in a three-watershed unit (the Southern Cattle Units) and the initiation of new stocking rates to complete the proposed experimental design. We began the second phase of the project in 2011, in the second three-watershed unit (Shane Creek Units). Seasonal grazing at moderate stocking rates (5 months/y stocked at 25 ha/ cow-calf animal unit) is applied to each 3-watershed area. A treatment employing traditional annual burning and season-long grazing characteristic for the Flint Hills grasslands in Kansas provides for a control comparison for each area. In addition, comparisons with ungrazed watersheds subjected to annual burns provide a second control for understanding the effects of fire-grazing interactions.

In spring of 2011, Sandercock, Wisely and colleagues started new long-term research on the effects of the new patch-burn grazing treatments on the ecology of grassland animals. Bird sampling was comprised of distance sampling on line transects to determine species diversity and avian abundance. Nest searching was conducted to locate nests of common songbird species and to examine spatial variation in rates of nest parasitism and nest survival. Bird sampling was conducted as a collaboration between Sandercock, William Jensen (Assistant Professor at Emporia State University, a 4-year college), Chris Then (an undergraduate at Emporia State University), and Akalak Kunsorn (a visiting PhD student from the University of Chiang-Mai, Thailand). The same field protocols were used for birds at Konza Prairie and also a separate set of field sites in Chase County near Cottonwood Falls, Kansas. In June 2011, Samantha Wisely and students initiated a study of the responses of small mammals to patch-burn grazing, with an emphasis on deer mouse demography. Small mammal communities were sampled with replicated trapping grids, utilizing standard techniques to examine responses of the small mammal community as a whole to this new range management technique. Additionally, we will employ artificial burrows, mark re-capture methods, and molecular techniques to gain a detailed understanding of deer mouse demography in rangeland communities in the northern Flint Hills. In addition to small mammal sampling, we will quantify any vegetative responses to patch-burn grazing with the standard habitat metrics of visual obstruction readings and percent cover of different cover classes such as forbs, grasses, litter, etc. Small mammal research involves Andrew Ricketts, a new PhD student on a GAANN fellowship from the Department of Education, and undergraduate Logan Blunk, a URM student.

The patch-burn grazing experiment is an excellent opportunity to increase linkages between programs in basic grassland ecology and more applied programs at KSU. Of equal importance, this will provide new outreach opportunities to encourage wildlife conservation and more sustainable practices by regional land managers and cattle producers. Dr. K.C. Olson, associate professor of cow-calf nutrition and management, is a new LTER collaborator for this project. His research includes nutritional management of cattle on native rangelands and factors influencing grazing behavior. Konza LTER scientists also visited Walda Prairie (a research site operated by the Kansas

Biological Survey), which is establishing a similar patch-burn experiment, and have consulted with Brian Obermeyer (Director of the Flint Hills Initiative for The Nature Conservancy) who oversees patch burn experiments at the Tallgrass Prairie National Preserve and the Flint Hills Tallgrass Prairie Preserve. Konza also hosted a visit by Dr. Joe Fargione (Regional Science Director of the Central U.S. Region TNC) in 2009, which included a visit to the Konza site and discussion of how to use the results from the patch-burn experiment to promote TNC goals. Finally, Konza LTER scientists (Dodds and Whiles) are participating in a cross-site comparison of impacts of patch-burn grazing on stream ecosystems at a site in Missouri and at Konza Prairie. Activities in 2009 and 2010 included establishment of new graduate student project to sample stream sites in Missouri, and gather preliminary data on streams within the future patch-burn watersheds at Konza. By coordinating and cooperating with the numerous patch-burn grazing experiments in our region, we will increase the visibility and applicability of our long-term grazing experiments.

Measuring Spatial Variability in Plant Physiology and Landscape Energy Balance Using Sensor Networks. Variability in topography, soil type, vegetative cover, and species composition all contribute to spatial variability in the surface energy balance across the landscape. Quantifying this variation is necessary to estimate carbon and water balances the scales used to make land management decisions (i.e., field or watershed scale). Furthermore, measures of spatial variability will aid in the interpretation of plant physiological responses of the grassland community, topo-edaphic variability in primary productivity, improve hydrologic modeling, and enhance the interpretation of data from remote sensing platforms and flux towers. We are using a 10-station sensor network deployed in 2 annually-burned watersheds and two 4-year burned watersheds to measure the spatial variation in the surface energy balance at 3 topographic positions. Measurements at each station included: air and soil temperature, canopy temperature, relative humidity, wind speed, surface temperature, soil heat flux, and soil water content. Data are accessible real-time using a wireless network. Ancillary bi-weekly measurements include vegetative growth, LAI, and plant height. Data from the sensor network and flux data from the eddy covariance towers are being coupled with a numerical modeling technique to approximate latent heat and sensible heat fluxes at each station in the network. Results to date indicate: (1) high spatial variability is present within and across watersheds and (2) topographic patterns of growth and canopy development vary strongly according to burn history. Few topographic differences were noted in infrequently burned watersheds (4-yr), while distinct topographic growth patterns are present in annually-burned watersheds.

We also continued expanded spatial coverage of net C exchange studies on two of the core LTER watersheds - one burned annually (1D) and one burned every four years (4B). In 2011, we initiated a subcontract with LTER collaborator Nate Brunsell (Atmospheric Scientist from the University of Kansas), which provides formal recognition of, and additional financial support for, his contributions to the LTER program. Through this subcontract, we also hired a new Atmospheric Science undergraduate student (Nathan Wendt) to aid in the eddy covariance studies at Konza. We maintained continuous data streams from two towers allowing comparison of fluxes from different land-use regimes (annual vs. intermediate prescribed fire frequencies) that result in areas with different plant community/life-forms (grass-dominated vs. significant woody vegetation expansion). These measurements will also be used to compare C flux measurements in tallgrass prairie an identical eddy covariance tower (installed in 2007) at the Nelson Environmental Study Area (NESA) outside of Lawrence, KS. Comparative data from this site will provide important new information on C flux in an area with higher annual precipitation than the Konza site

Evaluating the Effects of Climatic Variability and Climate Change in Tallgrass Prairie.
In addition to fire and grazing, our LTER VI research continues to focus on climatic variability as a critical factor affecting the structure and function of tallgrass prairie ecosystems. Within grasslands, the importance of both amounts and timing of precipitation inputs as forcing functions makes them particularly responses to inherent climatic variability and vulnerable to the changes predicted by global climate change models. Having a long-term dataset spanning decades of natural climatic variability is one important avenue for studying ecological responses to climatic variability (Nippert *et al.* 2006, Heisler and Knapp 2008, Craine *et al*. 2009, La Pierre *et al.* 2011). However, in LTER VI we continue several manipulative experiments designed to augment our long-term data and address potential mechanisms underpinning grassland responses to climatic variability and climate change. The first is an irrigation experiment, in which supplemental water is being added to two transects in annually burned tallgrass prairie to eliminate plant water deficits during the growing season (Knapp *et al.* 2001, Hutchinson *et al.* 2006, Williams and Rice 2007). This project began in 1991, and has been expanded to include a nitrogen addition treatment in order to evaluate potential interactions between precipitation and N limitations. A new synthesis of data from this project is currently underway, and was used to assess the applicability of a new model of ecosystem responses to chronic changes in levels of resource availability (Smith *et al.* 2010).

A second major project examining the effects of climate and climate change in these grasslands utilizes field-scale Rainfall Manipulation Plots (RaMPs) in which the timing and amounts of rainfall events are being experimentally manipulated in intact native tallgrass prairie plots (Fig. 3). This project, currently supported with additional funds from USDA, DOE and NSF LTREB, is allowing us to assess the effects of altered precipitation regimes on individual plant ecophysiological responses, plant community composition, and ecosystem-level processes. Details regarding the experimental approach and the initial results of this experiment are provided in Fay et al. (2000, 2003), and some recent results are highlighted in the accompanying 'Findings' section of this report. In addition to core long-term response variables on plant, soil and ecosystem responses to changes in timing of rainfall and warming, this project is currently being used in 2009-11 by graduate students from Yale to assess potential population-level genetic responses to climate change, and by a new collaborator from UC Santa Cruz (Weixin Cheng) who is funded with a DOE NICCR grant to use a stable isotope approach to separate root and bulk soil respiratory responses to climate change drivers.

Figure 3. Top: View of one of the Rainfall Manipulation Plots (RaMPs) prior to installing IR lamps. Bottom: IR heating lamps in a reference plot in the foreground. See text for a more detailed description of the shelter design and operation.

Plant Physiological Ecology: Linking Species-Specific Water Flux and Gas Exchange Dynamics to Hydraulic Architecture.
Identifying the consequences of grass blade morphology (long, narrow leaves) on the heterogeneity of gas exchange is fundamental to an understanding of the physiology of this growth form. We examined acropetal changes in anatomy, hydraulic conductivity, and rates of gas exchange in 6 grass

species (including C_3 and C_4 functional types). Both stomatal conductance and photosynthesis increased along all grass blades despite constant light availability. Hydraulic efficiency within the xylem remained constant along the leaf, but structural changes outside the xylem changed in concert with stomatal conductance. Stomatal density and index remained constant along grass blades but interveinal distance decreased acropetally resulting in a decreased path length for water movement from vascular bundle to stomate. The increase in stomatal conductance was correlated with the decreased pathlegth through the leaf mesophyll. Our results to date suggest that the relationship between leaf mesophyll and stomatal conductance previously identified across species also exists within individual leaves.

Plant Physiological Ecology: Phenotypic Variation in Switchgrass Populations.
Panicum virgatum (switchgrass) is a dominant plant species within tallgrass prairie ecosystems. Switchgrass is genotypically and phenotypically diverse, and commonly exhibits broad adaptation to a range of environmental conditions (Hartman et al. 2011). We planted 3 distinct ecotypes in a fully factorial outdoor mesocosm facility on Konza, and are assessing physiological and phenotypic differences within and among populations of switchgrass (Hartman 2011). Ecological and evolutionary differences in these populations will provide a better understanding of potential climate change effects on switchgrass, as well as broader impacts for the tallgrass prairie ecosystem driven by the responses of a dominant plant species. In 2010-11, this project involved collaborative research by LTER Co-PI Nippert, Dr. Clint Springer (St. Joseph University), and graduate and undergraduate students from both KSU and St. Joseph College (a non-doctoral degree granting institution).

Plant Population Ecology: Grassland Bud Bank Dynamics.
Previous KNZ-LTER studies by Hartnett and students have shown that the belowground population of meristems (bud bank) plays a primary role in plant population dynamics and community structure. LTER VI studies are examining the patterns and regulation of bud bank dynamics and their ecological consequences in grasslands. The objectives are to test: 1) an integrated model of the roles of light, nitrogen, and water as key regulators of bud dormancy and bud bank dynamics, 2) the hypothesis that a reserve bud bank is a key demographic mechanism explaining drought- and grazing-tolerance in grasses, 3) the "threshold bud bank density hypothesis" for resistance to exotic species invasions, and 4) the hypothesis that the bud bank buffers grass population responses to environmental change. A LTER study has recently been completed that assessed the role of proximal environmental cues (nitrogen, light intensity, and spectral quality) in bud production, dormancy and tiller initiation in six C3 and C4 grass species, and the patterns and dynamics bud banks of C3 and C4 grasses is being examined at KNZ and a C3 dominated northern mixed prairie (Wind Cave National Park). Relationships between bud bank densities and community invasibility by exotic species is being quantified in the field, and through experimental manipulations of bud bank densities in a recently completed microcosm study. In addition, new rainfall interception and irrigation plot experiments established in grazed and ungrazed sites on Konza (Ph.D. research by Ben Vanderweide) is examining the role of bud banks in resilience stability.

Perennial grass species in tallgrass prairie ecosystems are maintained primarily through the vegetative outgrowth from their belowground bud banks. A LTER study has recently been completed by Melinda Williamson (OSU MS student), Gail Wilson and Dave Hartnett to assess the role of nitrogen, light quantity and spectral quality as key regulators of bud bank dynamics and resultant tillering in six native grass species. We provide empirical data to assess interactions of nitrogen with light quantity, and the role they have on bud outgrowth and tiller initiation in six grass species in two functional groups (C_3 and C_4 photosynthetic pathways). We also examine the role of light spectral

quality (R:FR) on bud outgrowth in these same six grass species. Strong interactions between nitrogen and light were observed in the C_3 species, but not in the C_4 species. Generally, C_3 species responded favorably to N, while C_4 species were not responsive to N amendments. Light spectral quality elicited species-specific responses in both of the functional groups, with sensitivity to R:FR reductions observed in four of the six species. Therefore, C_3 and C_4 functional groups exhibited significantly different responses to these two cues. The results of this study suggest that environmental cues such as these may be important in determining patterns of species composition and population dynamics in response to current and future global changes.

Wes Sprinkle (OSU MS student), Ray West (OSU PhD student), Gail Wilson, and Dave Hartnett completed greenhouse studies examining varying densities of belowground meristems (bud bank) to test that grassland invasibility is regulated by a minimum threshold in bud bank density. Our data indicated that increases in size of the bud bank increased grassland stability, thereby reducing invasibility by exotic species. Biomass production of the exotic species profoundly increased in greenhouse mesocosms that contained no belowground meristems. A corresponding field study has been established on KPBS by Ray West. Plots have been established with 0%, 33%, 66%, and 100% of the native belowground meristems removed and an exotic grass species has been seeded into each plot. The first year of field data corresponds with that of our greenhouse studies, concurring grassland invasibility is decreased with stable belowground bud bank populations. These findings improve our understanding of plant invasion and suggest that restoring and maintaining bud banks should be a priority for land managers seeking to prevent and limit plant invasions.

Restoration Ecology and Grasslands.
Forecasting tallgrass prairie community and ecosystem response to environmental change is a core objective of LTER VI. Understanding the role of interannual abiotic and biotic variation on the reassembly of community structure and function broadens the regional of relevance of research from Konza LTER to the historical range of the tallgrass prairie, as restorations can constitute more grassland area than native prairie. Ongoing restoration experiments at the Konza Prairie LTER include: (1) the 1998-established soil heterogeneity plots, (2) the 2006-established cultivar and non-cultivar grass source plots that contain a seeded-diversity gradient along 5 subplots within each plot, and (3) the 2010-initiated chronosequence plots. The experimental treatments continue to be maintained in the soil heterogeneity plots (i.e., N addition through the application of fertilizer and N reduction through the addition of granular sugar). Plant community composition (spring and summer surveys of the percent cover of all species in permanent quadrats) in response to the soil heterogeneity treatments is being quantified in 2011 by S. Baer, representing the 14^{th} year of restoration, in preparation for a long-term synthesis paper. In fall of 2010, the cultivar experiment was sampled for species composition in all treatment combinations in partial fulfillment of R. Klopf's (SIUC) dissertation research. The SIUC Undergraduate Assistantship program supported an undergraduate to investigate aboveground net primary productivity and root biomass in the highest and lowest diversity treatments in the cultivar experiment. The first installation of plots to create a restoration chronosequence (space-for-time substitution) at Konza Prairie occurred in spring of 2010. Species composition (year 2) is being quantified at two scales (1 m^2 and 10 m^2) in permanently marked quadrats in each of the plots. The second installation of plots, to be seeded with the same species and at the same seeding rates used in 2010, will occur in spring 2012. Seed collection and processing is ongoing to achieve this objective.

Studies of Woody Vegetation Expansion into Grasslands.
Forest encroachment and the expansion of shrubs into grasslands is a widespread phenomenon, occurring in grasslands around the world. This is a serious conservation concern in tallgrass prairies, where woody plant encroachment leads to losses of grassland species and declines in biodiversity. There are also important potential changes in ecosystem processes accompanying grass-to-woodland conversions, though these have not been well documented in many grasslands. Woody plant increases can be directly attributed to alterations in land management (reduction in fire frequency) and may be indirectly facilitated by other factors (increased CO_2 concentration, N deposition, habitat fragmentation, etc.). We have been assessing the causes and consequences of this ecosystem conversion from C_4 grass to C_3 shrub-dominance by initiating and continuing studies on (1) on the landscape-scale pattern of conversion, (2) the mechanisms facilitating woody plant establishment and spread and (3) the ecological consequences of conversion from dominance by one growth form to another. Thus, we are evaluating the *patterns, mechanisms* and ecological *consequences* of an ecosystem in transition from C_4 grassland to closed-canopy C_3 shrub/woodland.

LTER investigator Briggs and students have been collecting data for woody plant cover on selected LTER watersheds since 1981 covering the range of burning treatments (annually burned, burned every ~4 years and a low-fire frequency (burned once since 1981)). In summer 2011, we are re-sampling those watersheds, using a high-precision GPS (~10 cm accuracy) to record the species, location, height (trees) and area (for shrubs) of the dominant woody plants in all selected watersheds. In addition, in 2001 we began a new experiment to assess the legacy effects of fire history on trajectories of response to altered fire frequency. Long-term fire treatments were 'reversed' on two watersheds previously burned annually in spring and two watersheds protected from fire for ~20 yrs (the 'Fire Reversal Experiment'). The new fire treatments started in 2001, and an assessment of plant and soil responses to the reversal of fire treatments was done in 2006 and 2011. In 2010-11, we continued re-sampling woody plant using GPS and field sampling methods on these watersheds. We are in the process of analyzing these data. In addition, these ground-collected data will be used as verification as we attempt to use various remote sensing platforms (Quickbird and aerial photographs) to estimate the cover of woody plants on watersheds that are not sampled using ground-based methods. The results of this study will be used to interpret the long-term responses to the fire reversal treatments, and will be relevant for new LTER VI experiments focused on the consequences of woody plant encroachment into grasslands.

LTER investigators McLauchlan, Craine, and KSU undergraduate students have been collecting increment bores from burr oaks (*Quercus macrocarpa*) in the King's Creek watershed to document the demographics of these riparian trees to complement other historical land cover estimates using aerial photography and land surveys. To assess possible moisture or nutrient drivers of changes in tree growth, we are measuring stable nitrogen isotopes and ring widths on these increment bores. The 19 increment bores analyzed to date show the largest establishment event after 1890 C.E. and a consistent decline in stable nitrogen isotopes around 1981 C.E. The youngest trees are located in the upstream locations in the watershed, consistent with earlier findings.

Abiotic and Biotic Controls of Predator-Prey Interactions.
Understanding how biotic and abiotic factors combine to affect species interactions is an important challenge in ecology. However, the effects of biotic and abiotic factors on species interactions are often studied separately. In 2010-11, we continued a multi-year field experiment (begun in 2007) using a model plant-grasshopper-spider food chain to understand how key biotic and abiotic factors (morning temperature, food quality, herbivore density, predation) interact to affect grasshopper performance and trophic interactions, including the occurrence of trophic cascades. Field enclosures containing one-, two-, or three- level food chains are placed over natural vegetation. Large chambers with movable roofs surrounding some of the enclosures are covered with plastic sheeting or 50% shade cloth to either increase or decrease morning temperatures. Because grasshoppers prefer warmer temperatures than wolf spiders, we can either expand or contract the amount of time that grasshoppers and spiders are both active by altering morning temperatures, thus influencing the potential for encounters between these species. Grasshopper–spider interactions are temperature dependent. At lower temperatures, predator effects are strengthened and trophic cascades are observed. However, when temperatures are increased, the effects of predators are weakened and no trophic cascades are observed. This experiment will help us gain a mechanistic understanding of how the environmental context influences species interactions. Furthermore, examining multiple biotic and abiotic factors simultaneously enables us to identify non-linear and compensatory interactions among factors that could not be identified by examining them separately.

Linking the Ecology of Migratory Birds in the Native Grasslands of North and South America.
Sandercock has conducted demographic research of Upland Sandpipers at breeding sites at Konza Prairie in Kansas and at nonbreeding sites west of Tacuarembó, Uruguay. In the winter of 2009-10, Sandercock and international collaborator Matilde Alfaro completed a third field season in Uruguay examining the seasonal survival and space use of nonbreeding sandpipers. We have now captured and deployed radios on 45 birds and have had no mortalities among sandpipers monitored at nonbreeding sites. Combining seasonal and annual estimates of survival from field work at Konza Prairie and Uruguay suggests that migration is the most risky period for migratory sandpipers. Our project is one of the first studies to combine seasonal and annual estimates of survival and provides important insights into the development and maintenance of migratory behavior in migratory birds.

Drivers of Fungal Community Composition in Riparian Gallery Forests and in Urban Green Oases
LTER scientist Dr. Ari Jumpponen recorded distinct differences in composition and richness of the phyllosphere and rhizosphere fungus communities in between urban/suburban green oases (including arboreal trees in parks and on campuses) and native riparian gallery forests. These successful programs have lead to broad collaborations with statisticians on (see Jumpponen et al. 2010c) and off campus (see Unterseher et al. 2011). We continue these collaborations to develop tools to model species co-occurrence in hyperdiverse and broad next generation sequencing data matrices. As a part of these research components we are comparing weighing models for multidimensional contingency matrices as well as network models. An additional question that emerged from these studies focusing on the composition and diversity of fungal communities in native oaks was what are the mechanisms that best explain the observed differences in community composition? To address this, we initiated empirical approaches that involve two REU and one URM students. Pure-culturing and heavy metal challenge approaches strongly suggest that conspecific fungi do not differ in their tolerances for the heavy metals that the urban environments are enriched for (Jumpponen et al. unpublished). Instead, fungal propagule loads and occurrence in phylloplane substrates are greater in the non-urban environments suggesting strongly that the observed patterns are primarily driven by isolation by distance from infection sources. The combination of these activities will contribute to better understanding of diversity, species richness and community function in native and urban

environments as well as to identification of mechanisms that may lay behind fungal community assembly. An additional benefit of these activities is that they provide a convenient avenue for outreach activities and broad collaborations. We maintain contact with Manhattan City Park Parks and Recreation managers, Manhattan City Foresters, regional arborists and Kansas State University Grounds Managers. We continue our collaboration with the Kansas State University's Center for Science Education that generated a hands-on classroom unit for a middle school in Great Bend, KS and have included undergraduates (including two REU and one URM) and graduate students (including a new GAANN student) into the new components of this research. Additionally, we maintain our collaborations with the two research groups in statistics to provide new tools and approaches to better evaluate the use of next generation sequencing in ecology.

Grassland Stream Studies.
Grassland stream studies are an important component of the Konza LTER program. Hydrology of Konza streams continues to be documented at four weir sites operated by the LTER program, plus a USGS gauging station located on Kings Creek and quarterly sampling of the fish assemblage at four permanent sites is ongoing. In 2010-2011, Dodds and his students completed experiments to assess both in-stream N transformations and denitrification processes in riparian areas with different land-use or land-cover, using a combination of field sampling and laboratory studies.
In 2010-2011, we continued long-term monitoring of stream discharge, chemistry, macro-invertebrates and fishes. In 2011, we also continued new monitoring of stream geomorphology and sediment transport, being led by a new collaborator from the KSU Department of Geography (Melinda Daniels). These data will yield new information over decadal time scales about sediment and nutrient transport, and how these trends are related to changes in woody riparian vegetation expansion and in-stream biodiversity, as well as the impacts on interannual climatic variability and associated stream hydrology. Whiles and a graduate student at SIU completed an examination of longitudinal patterns of invertebrate community structure and production, and system metabolism, along a prairie stream continuum from open headwaters to gallery forest. We also initiated new mesocosm experiments testing the effects of consumer diversity on ecosystem properties of tallgrass streams.

We continued two experiments in 2010-2011. Dodds, Whiles and Daniels continued a new cross site project titled "Biotic integrity of prairie streams as influenced by patch burn grazing and riparian protection" which is funded by the Missouri Department of Conservation for research at Missouri, and paired with estimates of response to patch burn grazing at Konza funded by the LTER. Through this effort, they are examining potential responses of Missouri headwater streams (water chemistry, physical habitat, biological integrity) to patch burn grazing with no riparian fencing and patch burn grazing with riparian fencing (and control watersheds with no grazing). This project is based on the Osage Prairie reserve in SW Missouri, and data from this study will be used in comparisons with data from the Konza LTER patch burn grazing experiment. Experiments at both locations concluded their pre-data period and cattle were placed on both sites in Spring 2011. The Konza treatments do not have fenced treatments, but can be compared to traditional cattle grazing, ungrazed prairie and bison grazed prairie. This project will also have relevance for regional cattle management, as patch burn grazing is rapidly gaining favor as a management tool for tallgrass prairie remnants and restorations, but we there is little data on how it may impact biotic integrity in and water quality of headwater streams. We found that ecosystem characteristics are similar across these two sites, with good water quality characteristic at both sites. We also added more detailed geomorphological sampling at both sites, and with an undergraduate student funded through the Konza REU project, did preliminary sampling on relative levels of fecal coliform and *Eterococcusfaecalis*. Dodds' MS student, D. Russell, also added an intensive herpetofaunal component to the research at the Missouri study sites.

In 2008-09, we initiated the LTER VI riparian vegetation removal experiment in two watersheds where a 30- 50m stretch of woody vegetation was removed in a 20 m wide swath. Initial results indicated strong response of filamentous algae to the vegetation removal. The analyses of results of this experiment will be completed in 2011.

We continued work on the whole-watershed riparian vegetation removal project. We finished preliminary (pre) sampling of sediments, algae, stream invertebrates, and riparian spiders for a more extensive (entire watershed) removal. K. Erndt (Ph.D. student and IGERT fellow at SIU) is leading the in-stream and riparian invertebrate responses component of this study. We also completed baseline sampling of geomorphology, oxygen dynamics, riparian sediments, and vegetation transects. Pre sampling ended in Winter 2011 and post-manipulation sampling is now underway.

During Winter 2010-2011 woody riparian vegetation was removed from 4.8 km of stream riparian area, 30 m from each side of the main channel, and 10 m for small side channels on watershed N02B. Our hypothesis is that headwater streams yield less water and retain more nutrients with increased riparian canopy cover. We expect that increased riparian forest cover reduces stream water flow (as a result of increased transpiration), reduces grasses that retain sediments, and subsidizes the stream channels with nutrient-poor/ carbon-rich leaves, leading to greater nutrient retention. We predict that woody invasion alters aquatic invertebrate communities and riparian vegetation and invertebrate populations. Long term data suggest reduced water yield with no substantial changes in precipitation or temperature on Konza, providing correlative data for reduced water yield related to riparian vegetation. We mechanically removed all woody vegetation within 10 m of either side of a 4-km reach immediately upstream of a weir with a long-term hydrology and water chemistry record (N02B), and will continue to mechanically control woody vegetation for 6 yrs. We have 2 comparison gauged watersheds and 15 yrs of before-removal water quality data from this watershed. We will continue our standard monitoring regime at this weir to assess the effects of the riparian removal on nutrient and sediment transport. We are examining a variety of potential biological responses to this removal including 1) stream invertebrates, 2) riparian invertebrates, 3) riparian vegetation, and 4) riparian soil fungi. We also initiated a riparian restoration comparison by re-seeding smaller areas of the removal.

LTER investigators Whiles and Gido continued investigations of stream community structure function, stream food web dynamics, and patterns and controls of secondary productivity in grassland streams. Long-term monitoring of fish communities in 2011represents the 16th year of data collection from Kings Creek. In addition, we completed the 3rd year of parallel monitoring in Fox Creek on the Tall Grass Prairie Preserve (approximately 80 km south of Konza), which was initiated to help regionalize data collected from Konza. Frequent sampling along a gradient of headwater springs to downstream perennial reaches will help us understand the importance of landscape connectivity on the stability of native fish populations. In summer 2010, graduate student Erika Martin conducted a mesocosm experiment testing the effects of consumer density and community diversity on ecosystem properties of prairie streams. A companion study will be initiated in summer 2011 to test a similar question using a larger configuration of experimental stream. This study will help evaluate our ability to scale results from small scale experiments to entire stream reaches.

A new stream geomorphology program was initiated in 2010, establishing long term monitoring sites in 10 Konza watersheds across a range of fire and grazing treatments and including the riparian removal watershed. Initial baseline samples of channel cross sectional morphology and sediment substrate characteristics have documented significant differences between ungrazed, bison grazed and cattle grazed stream channels. Bedload transport and suspended load transport traps have also

been installed in all 10 study streams and initial samples, while still in the early stages of analysis, also seem to demonstrate substantial process differences between grazing treatments. We are now in the process of extending the monitoring network beyond Konza to complimentary regional sites. Konza LTER has partially supported one PhD student (Bartosz Grudzinski, KSU Geography) to conduct this work.

Groundwater Hydrology and Geochemistry
In addition our surface stream studies, we continue to monitor physical and chemical hydrogeology, including water levels, nutrients and water geochemistry under the direction of Gwen Macpherson (KU). Water levels in all wells at Konza N04D watershed and water chemistry in selected wells continue to be measured for the long-term data base; high-frequency (5-minute) data collection of water-level and temperature continues in one well. Some of the water-level data was used as part of the calibration for a new 5166 km^2regional model, recently completed under the direction of David Steward (KSU), that shows the hydrogeology of the Konza LTER site in the context of regional groundwater flow.

Water geochemistry investigations include a KU M.S. student's (MishaTsypin) thesis research (2010-11)which has focused on soil- and groundwater chemistry and gases, dissolved species and stable isotopes, in relation to major rainfall events. We installed CO_2-gas-sampling wells and new lysimeters in support of this project. Data collection is complete and manuscripts are in progress. A new effort is underway to better measure groundwater pH at the site, with support from the Konza LTER for a downhole pH sonde and from the KU Dept. of Geology for a field computer to operate the sonde. An undergraduate (KU: Gilbert Ching) under Macpherson's direction is working (summer 2011) to compare the sonde pH with more traditional methods of measuring field pH. pH is a critical parameter for calculating saturation states of common minerals at Konza (calcite, dolomite), and for assessing groundwater CO_2 levels.

An undergraduate (KU; Rachelle Warren), under Macpherson's direction, is investigating the chemistry of throughflow (soil water moving ~horizontally from recharge point toward streams) produced during rapid snowmelt events (RSEs), assessing the micronutrient and some of the macronutrient content of the water. Two events have been sampled (2009 and 2011) and climate data are being examined to assess any long-term changes that might lead to more frequent RSEs. Macpherson is currently working on interpretations of elemental chemistry data from sequential chemical extractions of soil; the soil environment is the first environment encountered by water that eventually recharges groundwater, and so has a large influence on the groundwater chemistry. Macpherson also continues work to investigate the possibility of long-term trends in chemical weathering at the Konza LTER site (Macpherson, 2010), considering the long-term increase in groundwater CO_2.

Application of a Spatially-Distributed Ecohydrology Model to Konza Prairie (Bob McKane and others). The USEPA, Georgia Institute of Technology, and Kansas State University are collaborating to develop and apply the VELMA ecohydrology model to the Konza Prairie LTER site. VELMA links hydrological and biogeochemical processes in a spatially-distributed (GIS) framework. We used VELMA to simulate the cycling and transport of water, carbon and nitrogen within the 11 km^2 Kings Creek Watershed at the Konza Prairie. Data visualization tools built into the model provide a spatial and temporal understanding of patterns of nutrient uptake and turnover in plants and soils, and terrestrial flow pathways of water and nutrients to surface waters. For example, Konza Prairie simulations for 1991-2006 describe daily and inter-annual variations in stream water quality and quantity, plant productivity and carbon sequestration at a scale of 30 x 30 meters. During

2010-2011 we enhanced VELMA for simulating much larger landscapes having a complex mosaic of land use and land cover types, e.g., the 1,000 km^2 Mill Creek watershed near Konza Prairie. Our goal is to establish a user-friendly decision support framework that policymakers and stakeholders can use to examine how alternative climate and management (burning, grazing) scenarios affect trade-offs among multiple grassland ecosystem services – forage production, carbon sequestration, and regulation of water quality and quantity. We are developing this framework for regional decision support applications for the 30,000 km^2 Flint Hills ecoregion of eastern Kansas. This project will also provide the necessary computational and decision support capabilities for generating spatially-explicit fuel load data in support of regional air quality assessments. The remote sensing and air quality modeling component of this work is being conducted under a NSF-funded project by Dr. Doug Goodin of Kansas State University and Dr. Scott Goodrick of the U.S. Forest Service.

Remote Sensing and Fire Frequency (Doug Goodin and others) - Optical remote sensing is widely used for mapping burned area in a wide variety of ecosystems including tallgrass prairie. Typically, these remote sensing observations rely on the spectral contrast between the burn remnant and its surrounding non-burned vegetation. Numerous methods for extracting this information have appeared in the remote sensing literature, however the majority of these methods have been developed for use in forests or cropland – systems where the spectral contrast between burned and unburned is great and the contrast does not change rapidly over time. Tallgrass prairie presents a challenge for burn mapping because the burn season typically occurs just before (and in some cases at the beginning of) the active canopy season, thus the burn remnants occur against a continually changing background. In addition, the technical challenge of burn mapping in tallgrass prairie is increased because the burning season coincides with the cloudiest time of the year, and also because the burns are often rather small relative to the spatial resolution of the satellite sensors most suitable for mapping them. Addressing these problems requires a more detailed understanding of the temporal pattern of spectral reflectance of burned and unburned prairie. We addressed this problem by collecting in-situ radiometry samples from burned and unburned sites at Konza Prairie. These In situ hyperspectral radiometer samples of burned and unburned tallgrass prairie were used to simulate several MODIS bands and indices that are commonly used for burned area detection. These indices were tested for their ability to differentiate between burned and unburned areas starting at the time of burning (April) and ending in late August.

Of the existing burn indices we tested. Most showed some ability discriminate between burned and unburned sites immediately after the burn had occurred. However, the discriminant ability of most of these indices decayed very quickly. Of particular note was the fact that the Normalized Difference Vegetation Index (NDVI) a widely used data product in remote sensing, showed virtually no ability to identify burns more than a few days old. Fire-specific spectral indices such as GEMI, GEMI-B, NBR, and MODIS band 7 (LMIR), also showed little capability for differentiating burned from unburned areas longer than several days after the burn. Others, including BAI, MIRBI, and MODIS bands 3 (red), 4 (NIR), 5 (LNIR), and 6 (SMIR) were able to differentiate between burned and unburned areas well into the growing season—in some cases even through the entire length of the sample. The performance of particular bands and indices often depended on grazing and other factors that influenced pre-burn biomass.

Social Science Activities

Konza LTER investigators, led by John Harrington (KSU, Professor of Geography) continued several cross-site activities supported, in whole or part, by social science supplements to the core LTER grant. These activities included: (1) The LTER cross-site fragmentation effort (with CAP, SEV, SES, and JRN) and (2) the LTER cross-site MALs (Maps and Locals) effort. A co-authored

article in Urban Ecosystems (by York et al. and available on-line first in Feb. 2011) summarized the cross-site fragmentation effort. MALs is a collaborative effort of LTER sites that seek to study changing social-ecological systems using a mixed methods comparative approach. The project was launched in 2009 through the Social Science Supplement funding opportunity of the LTER Network and a second round of funding was obtained in 2010. The objective of MALS is to: 1) use spatial representation of land cover and land use to identify patterns of landscape change in regions in and around LTER sites; and, 2) integrate Local Ecological Knowledge (LEK) and other existing social data into theories and models of social-ecological change and their implications for human livelihoods. Forty-two interviews on LEK were obtained in the summer of 2010 and that qualitative data was the substance of Iris Wilson's Master's thesis (Perceptions of Climate and Environmental Change in Northcentral Kansas). The MALS group has met three times in the last year to share findings, build ideas, and make plans for a CNH proposal to NSF. A co-authored manuscript is in draft form and should be submitted by August 2011. Plans are in place to submit a MALS related follow-on proposal to NSF for the November 2011 CNH competition.

21th Annual Konza Prairie LTER Investigator's Workshop.
The Konza Prairie LTER program hosted its 21st annual LTER Workshop on April 16, 2011, at the Konza Prairie Biological Station Meeting Hall (KMH). The KMH is the result of an extensive renovation of an historic limestone barn, built in 1910. Extensive remodeling of the former barn, completed in fall of 2008, created a modern and highly flexible meeting space at the field station, while preserving the historic character of this traditional early 20th-century stone building. The facility includes the Cortelyou Lecture Hall, which seats approximately 100 people and includes high-quality A/V capabilities and wireless internet access. The KMH also includes a large multi-purpose room, which includes 1,850 square feet of space that can be configured for workshops, posters and other research displays, social gatherings, and education programs. The Konza LTER workshop is an annual event that brings together senior scientists, students and staff for a day of research presentations, planning activities, and informal social interactions. These meetings are increasingly important for bringing together local and off-campus investigators. The 2011 workshop included investigators, students, staff and docents from Kansas State University, as well as researchers and students from Colorado State University, Oklahoma State University, Southern Illinois University, and Yale University. The 2011 workshop focused on preparing for the NSF mid-term review, and included a full day of oral presentations by LTER senior scientists, as well as poster presentations from graduate students and co-investigators. Topics ranged from soil and plant processes, to grassland stream ecology, to impacts of regional land-cover change. Presentations included updates on the status of ongoing LTER activities, highlights of recent research accomplishments, and planning for new experiments being implemented as part of the Konza LTER VI renewal. An LTER PI planning meeting followed the formal presentations.

Information Management.
Information management continues to be an essential component of the Konza Prairie LTER program. In 2011 Adam Skibbe and Carol Gadbury, Information Manager and Archivist respectively, were assisted by part-time student employees Tammy Sonnentag and Caleb Siebel (data enterers), Rahul Choubey, Leela Anusha and Arthi Subramanian (programmers) and Courtney Estes (geographic information systems).

In 2011 we continued to work towards our long-term goals (assuring data integrity and security; facilitating access to datasets and metadata; enhancing the utility of data and metadata for current and future generations; ensuring compatibility with current LTER standards and best practices, and with the developing Network Information System (NIS), with added focus on preparation, and completion

of key projects, for the June 2011 NSF site review. Part of this effort included the release the new Konza LTER website (http://www.konza.ksu.edu/knz/). The site was designed with accessibility and ease of use in mind (for users and for maintenance), and follows LTER best practices for website design.

A major goal is to make all new LTER data available on-line as soon as possible, as well as continuously working towards filling in any gaps that may exist in our digital holdings. Additionally, we wish to point out that these on-line data continue to be made available to outside investigators without restriction. We have expanded our data access and discovery capabilities with a variety of search and browse options in the "Data" section of our new website. With the new website, we offer data both as ASCII text files as well as via a SQL Server download with a query option. In 2011 we completed a series of updates to our metadata and will continue to migrate these to a more complete EML. We continue to offer metadata in multiple formats. In addition, all data is extensively checked for QA/QC to ensure final products are accurate.

The Konza LTER IMS includes an up-to-date list of all Konza LTER publications including journal articles, conference proceedings, books and book chapters, theses and dissertations, and electronic publications supported by Konza LTER program. The list is searchable by key words, author name, and date. We have linked personnel with publications through a dynamic connection with our SQL Server database, making it easy for users to find specific personnel information and related publications. In 2011, Mr. Skibbe, with the help of student programmers, designed and deployed an internal content management system (CMS) to better manage our web content, personnel and publications databases. This system has resulted in a much more user friendly and reliable web site as well as the ability to make prompt future updates to web content.

An additional important activity of the Konza LTER IMS has been the organization and digitization of all original field data, including many field notes and maps dating back to the beginning of the LTER program. We have created and moved copies of all original field data off site to ensure security and long-term retention in the event of a local disaster. Additionally we have scanned all original field notes and data, and we can now provide digital scans (.pdf) to complement our SQL and ASCII version of the data for every available dataset. Our intent is to make these scans internally available so those interested in cross checking data or viewing original datasheets can have access without having to visit the archives.

Mr. Skibbe continued to collaborate with other LTER information managers on the LTERMapS network-wide online GIS mapping interface (http://www.lternet.edu/map/). Work on phase two of this project will be a focus for the upcoming year, with emphasis on inclusion of a GIS mapping interface in the LTER NIS. In addition to this shared resource, we are working towards a better online mapping presence for the Konza LTER (both applications and services). The Konza LTER program also continues to work towards increasing our spatial data offerings, both in historic data as well as newly collected data, with special emphasis on offering a complete series of burn history data (update completed May 2011), digitizing and rectifying a series of historic aerial photographs, and developing a detailed GIS of past and currentresearch plot locations. We continue to offer our base layer spatial datasets as downloads (.e00 interchange or .shp shapefiles) and their associated FGDC ESRI and EML metadata.

In 2011, we continued to update a variety of our metadata and procedural protocols to ensure any changes in technique or structure of our datasets are accounted for. Specifically, we finalized the updated (as of June 2011) editing our data catalog (metadata), our methods manual (techniques), as

well as our data entry procedural handbook. In addition, we established an improved workflow for data processing (from field data collection through entry, and QA/QC) to support prompt data entry and updates. We also began planning for more current and interactive interfaces for data entry and query. Our goal is for individuals working on data entry to be able to use these interfaces to send data directly to our database following QA/QC procedures.

Educational Activities.
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 2008-2011: Colorado State University (Greg Buis, Amanda Lease, David Hoover, Kevin Wilcox, Ashley, Shaw, Jenny Song), Cornell University (Rebecca Lohnes), Southern Illinois University (Ryan Klopf, Dan Whiting, Kim Erndt, Jodi Vandermyde), St. Joseph's University (Kim O'Keefe, Nick Tomeo), Yale University (Cynthia Chang, Meghan Avolio, Kimberly LaPierre, Beth Forrestel), Oklahoma State University (Wes Sprinkle, Ray West, Melinda Williamson), University of Kansas (Lisa Tiemann, Tyler Buck, M Petrie), University of Kentucky (Bridget Sousa), 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 2011, we supported 2 LTER REU students with supplements, and contributed support to the REU site program. Summer 2011 was the 16th 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 led by LTER investigators Samantha Wisely and Ari Jumpponen. The URM grant focuses on incorporating ecological genomics research in KSU undergraduate training. Although this URM program is not focused exclusively on the Konza Prairie LTER, four of the six students use Konza LTER as a primary field site for their research. REU students were recruited nationwide and primarily from undergraduate institutions with limited opportunities for research: Grinnell College (IA), Missouri State University (MO), Saint Joseph's University (PA), Skidmore College (NY), Swarthmore College (PA), University of Dallas (TX), University of Illinois at Urbana-Champaign (IL), University of Michigan at Ann Arbor (MI), University of Puerto Rico at Mayguez (PR), and University of Tennessee at Knoxville (TN). The URM program is a full year program and the URM students were recruited from K-State. The 17 REU/URM students included 10 women and 3 underrepresented minority students. All students were matched with a research mentor and provided with opportunities for independent research. Recent research output from the Konza REU program included 12 peer-reviewed articles. Publications spanned a diversity of topics, including genomics of grassland plants (Kawakami et al. 2010, 2011, 2011b), plant ecology and ecophysiology (Johnson et al. 2010, Mandyam et al. 2011, Nippert et al. 2011, VanderWeide et al. 2011, Walker et al. 2011), trophic interactions (Klug et al. 2010), and ecosystem science (Craine et al. 2010, Kohler et al. 2011, Craine and Gelderman 2011).

The Konza Prairie LTER program has a strong history of providing research experiences for students from under-represented groups, which we strive to continue during LTER VI. In the past, we have participated in the ESA SEEDS (Strategies for Ecology Education Development and Sustainability) program. In 2005 we hosted two SEEDS students working on the Konza site, and in 2006, we hosted one SEEDS student. From June 4-9, 2006, the Konza Prairie LTER program hosted a SEEDS student field, which included 19 students from 16 schools across the country, including the territories

of American Samoa and Puerto Rico; one SEEDS faculty from Yale University; and three SEEDS staff from the Ecological Society of America. The program for this involved field and laboratory activities that included a large number of LTER PIs and graduate students, and was well received by both ESA staff and SEEDS students. A report on the Konza field trip is available on the SEEDS web site (http://www.esa.org/seeds/fieldtrips/past.php). In 2009, one of our former REU students (Jorge Mendoza, REU in 2008) was selected for the KSU Developing Scholars Program, and paired with Konza LTER investigator Brett Sandercock as his research mentor (www.k-state.edu/media/newsreleases/jan09/mendoza11309.html). In 2001, Konza undergraduate student researcher Graciela Orozco (mentored by LTER co-PI Jesse Nippert) was selected for KSU's McNair Scholars program, which prepares underrepresented and first generation students for successful careers as graduate students, professors and professional researchers (www.k-state.edu/media/newsreleases/feb11/labtechs21511.html).

The Konza Schoolyard LTER program is the centerpiece of the Konza Environmental Education Program (KEEP), and continues to be active at both the site and network levels. The Konza Prairie Schoolyard LTER database was recently completed, and is used by a large number of SLTER classes. These "student-friendly" datasets are designed to allow Web-based data entry, query, analysis and graphing of data collected by students at KPBS. These datasets can also be compared with companion datasets adapted from the Konza LTER data library through a Web-based interface. Our program provides these teachers with the educational resources to incorporate field biology and ecological science into their classes, an area which has not received adequate attention or resources in many school districts. All of our science activities are correlated with state and national standards. Further details on the K-12 education program are provided in the Training and Development section of this report.

A novel aspect of our K-12 education program is the development of databases on plant and animal phenology (timing of plant or animal growth and activity) from sites across the state. Students can compare the dates of first biological events for plants (flowering, senescence) and animals (adult insect emergence, mammalian activity) in regions representing varied climates and prairie types across Kansas. This database will allow students to look for trends and changes in emergence or bloom, which are indicative of natural climatic variability, as well as potential directional climate change (www.ksu.edu/konza/keep/phenology.asp). This activity grew out of a local effort by the Konza Environmental Education Program (KEEP) to database Konza Prairie phenological events with the help of "citizen science" volunteers. Volunteer participation in this local program has increased annually. In the future we hope to expand this program to volunteers in small communities statewide where we also have Satellite SLTER sites.

Cross-Site and LTER Network-Level Activities.
Konza LTER scientists continue to lead and participate in numerous cross-site research projects (with both LTER and non-LTER sites) and LTER Network-level activities. For example, Blair, Knapp and Smith have been regular participants in LTER planning for the future (i.e., the ISSE initiative) and many Konza scientists lead or participate in various LNO and cross-site activities (e.g., the Climate Change working group, Experiments within the LTER network, etc.). Blair chaired the 2011 Science Council meeting Planning Committee, presented at the 2011 NSF Mini-Symposium, and currently serves on the LTER Executive Board (2011-2014). Knapp chairs the publications committee, and Goodin has been a long-time participant on (and former Chair of) the LTER Climate Committee. Other contributions to LTER Network-level activities include service by John Briggs on the Network Information System Advisory Committee (NISAC), and service by David Hartnett on the US ILTER committee. John Harrington contributed to four recent LTER Network-sponsored workshops on

integration of social and ecological sciences, and several Konza scientists have had an active role in the EcoTrends project. Konza LTER scientists and students are participants in the Nutrient Network (NutNet) Global Research Cooperative (locally led by M. Smith). There are numerous other examples of cross-site research activities being led by Konza LTER scientists.

The Konza LTER site also continues to be used by researchers from other sites and institutions for a variety of cross-site comparisons. Examples of recent and ongoing studies being done at the Konza Prairie LTER site include:

- assessing the role of evolutionary trade-offs in enzyme activities in microbial community function, led by Mark Bradford (Yale), Noah Fierer (U Colorado) and Rebecca McCulley (U Kentucky)

- a cross-site comparison of soil microbial-plant interactions in fertilized and unfertilized soil, led by Katie Suding (UC Berkeley)

- isotopic approaches to separate heterotrophic and autotrophic sources of soil CO_2 and their responses to warming and altered precipitation in grassland ecosystems, led by Dr. Weixin Cheng (UC Santa Barbara)

- studies of the patterns and controls of soil black carbon storage, a multi-site study directed by Johannes Lehmann (Cornell University);

- studies of trace gas flux from mesic grasslands led by Emily Elliott (U of Pittsburgh)

- stable isotope studies of litter decomposition directed by Francesca Cotrufo (Colorado State University);

- studies of soil microbial community composition, C cycling and responses to altered precipitation patterns, a multi-investigator project directed by Dave Myrold (U of Oregon);

- studies of the role of dissolved organic C in streams from a range of ecosystem types, directed by Dr. Rudolph Jaffee (Florida International University)

- a cross-site study of methane uptake rates and the identity of methane oxidizing bacteria, led by Dr. Joe van Fischer (Colorado State University)

International Collaboration
Konza LTER scientists are also involved in a variety of international collaborative efforts. For example, Konza LTER scientists and scientists from South Africa are conducting collaborative studies of ecological responses to fire and grazing in North American and Southern African grasslands [J. Blair (KSU), M. Smith (Yale), Alan Knapp (CSU), Scott Collins (UNM) and collaborators in South Africa (Kevin Kirkman and Richard Fynn at the University of KwaZulu-Natal, Pietermarizburg)]. In 2009, Konza LTER c-PI Jesse Nippert used support from the Provost's office at K-State to initiate a new collaboration with Dr. Tony Swemmer at the South African Environmental Observation Network (SAEON) in Phalaborwa, South Africa. SAEON supports a long-term network of *in-situ* environmental observation monitoring and data collection, the equivalent of NEON in the United States. In 2010, Nippert was awarded an international supplement

to our core LTER grant to continue and expand these studies on the impacts of woody plant encroachment into South African grasslands, which complements similar work being done at Konza. Konza co-PI David Hartnett maintains collaborations with colleagues in Botswana, and has supported exchanges of graduate students there. Hartnett and students continued their studies of the comparative population ecology of grasses of North American grasslands and southern African savannas. A study of patterns of belowground bud banks, root system architecture, and mycorrhizal symbiosis in 18 southern African semi-arid savanna grasses is currently in progress. A novel finding of this research is that, in some African grasses, mycorrhizal fungi and fungal exudates form a protective sheath around roots, and sheath thickness appears to increase with increasing aridity. This may be an important trait increasing the drought-tolerance of grasses in increasingly arid environments. Hartnett led a 2009 summer study-abroad field course on the "Ecology of African Savannas", providing international field experience for both KNZ-LTER graduate students and undergraduates and in 2010 published a paper in the Bull. Ecol. Soc. Amer. entitled "Into Africa: Promoting international ecological research and training in the developing world". In addition, Hartnett and Joern are Co-Directors of the Institute for Grassland Studies at KSU, which promotes international collaborative research on grassland ecology, and in 2009 Hartnett led a field class on a trip to South Africa and Botswana. In 2010, Konza LTER scientist Brett Sandercock continued a collaborative study (funded by an LTER international supplement) with scientists in Uruguay to assess population dynamics of a migratory grassland bird (the Upland Sandpiper) in its northern and southern hemisphere ranges. Konza LTER scientist Samantha Wisely is working with students in Paraguay on wildlife conservation issues. In 2009, Konza Prairie LTER Scientists were invited to China to consult on grassland and herbivore studies (Joern) and to participate in an international conference (Blair and Knapp) organized by the Chinese Academy of Sciences, and in 2010 Konza supported reciprocal visits from 4 Chinese scientists. Konza Prairie continues to host numerous visits by international scientists and students, including (in 2008-10): Dr. Marjan Jongen of the Instituto Superior de Agronomia, Lisbon, Portugal; Matilde Alfaro-Barrios of Averaves-Investigación y Conservación, Uruguay; Dr. Shuguang Hao (Chinese Academy of Sciences); Dr. Yingzhi Gao (Northeast Normal University); Dr. Nianpeng He (Director, Inner Mongolian Grasslands Ecosystem Research Station), and Dr. Xin Xiaoping (Director, Hulunber Grassland Observation and Research Station). The Konza LTER program also provides on-site research opportunities (as well as logistic and/or financial support) for graduate students from a number of international venues (e.g., in 2008: Elske Koppenaal, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, South Africa).

Planning Underway for 2011 International Grasslands Symposium

On September 12-14, 2011, Kansas State University will sponsor an international symposium, entitled "*Grasslands in a Global Context*" (www.dce.k-state.edu/conf/grassland/). The symposium is planned to celebrate important milestones reached at Konza Prairie Biological Station (KPBS) and the associated Konza Prairie Long-Term Ecological Research (LTER) program. The KPBS was established in 1971, and the Konza LTER program formally began in 1981 with support from the National Science Foundation and has grown into a world-class grassland ecological research facility and program. Research at Konza has also shifted over these 30 years from a more regional long term perspective to one of global use and scientific implications. The conference aims to develop a current, comparative synthesis of grassland/savanna ecosystems within a global framework. With the development of Konza Prairie as a global research platform in grassland studies coinciding with the benchmark 30th and 40th year anniversaries of our research station and LTER program, the stage is set for a synthesis of past, ongoing and new research results in the context of global understanding of grassland systems. This synthesis is aimed at identifying generalities in the structure and function of

grassland and savanna ecosystems around the globe, recognizing continental level differences of critical importance, while identifying significant research gaps that can drive future studies.

Konza-Related Extramural Grants (not including LTER funding) active during the current reporting period (2010-2011)

Blair, J.M. and A.K. Knapp. 2007-2011. Collaborative Research: Interactive effects of altered rainfall timing and elevated soil temperature on soil communities and ecosystem processes. DOE National Institute for Climate Change Research, $502,552.

Blair, J.M., A.K. Knapp, S.L. Collins, P.A. Fay and M.D. Smith. 2005-2011. Collaborative Research: LTREB long-term ecosystem responses to more extreme precipitation patterns and warming. NSF LTREB Program, $300,000.

Briggs, J.M., D.C. Hartnett and E.A. Horne. 2011-2014. FSML: Expanding lodging capacity for visiting researchers at the Konza Prairie Biological Station for the enhancement of research and training opportunities. NSF FSML program, $238,030.

Cheng, W. 2009-2011. Separating sources of soil CO2 and their responses to warming and altered precipitation in a grassland ecosystem. DOE National Institute for Climate Change Research, $246,273 (University California – Santa Barbara).

Craine, J.M., Fierer, N., and McLauchlan, K.K. 2008-2011. Testing the consequences of the carbon-quality temperature hypothesis for soil organic matter decomposition. NSF Ecosystems Program, $437,157.

Dodds, W.K. 2008-2010. Ecological integrity of prairie streams as influenced by patch-burn grazing and riparian protection. Missouri Department of Conservation, $130,000 (KSU portion).

Dodds, W.K, and D. Andreson. 2009-2012. Collaborative Research: EPSCoR R 11 Track 2 Oklahoma & Kansas: A cyberCommons for Ecological Forecasting. NSF EPSCoR, $1,608,168 (KSU portion).

Dodds, W.K., K. Gido, F. Ballantyne, W. Wollheim, A. Helton, M. Whiles, A. Rosemond, J. Kominoski, W. Bowden, M. Flinn, J. Jones, T. Harms, and W. McDowell. 2011-2016. Collaborative research: Scale, Consumers and Lotic Ecosystem Rates (SCALER): Centimeters to continents. $ 1,198,082 (KSU portion).

Hartnett, D.C. and G.W.T. Wilson. 2007-2010. Bud bank demography: A new approach to assessing rangeland health and responses to environmental change. USDA Rangeland Research Program, $399,384.

Herman, M.H. 2009-2011. EAGER: Studies of native grassland soil nematodes to develop genomic approaches to study community responses in non-model taxa. NSF, $40,000.

Herman, M.H., K.L. Jones, T.C. Todd and J.M. Blair. 2007-2010. En-Gen: Ecological genomics of soil nematode community responses: Model and non-model approaches. NSF Environmental Genomics Program, $622,598.

Joern, A., J.M. Briggs, D. Goodin, A. Skibbe and E.G. Towne. 2010-2013. Impacts of spatially heterogeneous nitrogen on grazer distribution and activity: Effects on ecosystem function in tallgrass prairie. NSF, $750,000.

Joern, A. and D.C. Hartnett. 2008-2011. Enhancing excellence in grassland ecology: a center for basic grassland research at KSU. KSU Provost's Targeted Excellence Program, $515,000.

Johnson, L.C., S.G. Baer and others. 2008-2011. Ecotypic variation and functional response of an ecologically dominant species across a precipitation gradient and in response to altered precipitation: Test for local adaptation and ecosystem function. USDA Plant Biology and Abiotic Stress Program, $394,439.

Johnson, L.C., B.K. Sandercock, M.A. Herman and A. Joern. 2009-2012. Ecology, evolution, and genomics in changing environments. Graduate Assistance in Areas of National Need (GAANN), Department of Education, $783,936.

Kelly, E.F. and A.K. Knapp. 2008-2010. Ecological controls on biogenic silica in grasslands - the role of long-term fire and grazing history on two continents. NSF Ecosystems Ecology Program, $250,000.

Knapp, A.K., J.M. Blair and M.D. Smith. 2007-2010. Grassland structure and function in response to warming and more extreme precipitation patterns. USDA NRI Managed Ecosystems, $399,720.

Koerner, S. and S.L. Collins. 2009-2011. Dissertation Research: Effects of global climate change, loss of mega-herbivore biodiversity, and altered fire regimes on savanna grassland ecosystems. NSF DDIG Program, $14,860.

McKane, R.B. 2009-2011. Development of a decision support framework for assessing the effects of land management decisions on ecosystem services in the central Great Plains region-an EPA Region 7 Regional Applied Research Effort. USEPA Office of Science Policy, $50,000.

McLauchlan, K.K. and S. Sugita. 2008-2010. Improving reconstructions of open vegetation in North America: pollen productivity estimates for grassland plants. NSF Geography and Regional Science Program, $90,005.

McNew, L.B., J.C. Pitman, and B.K. Sandercock. 2010-2013. Impacts of alternative grassland management regimes on the population ecology of grassland birds. Pittman-Robertson Act Funding, Kansas Department of Wildlife and Parks, $633,626.

McNew, L.B., B.K. Sandercock, and J.C. Pitman. 2012-2014. Effects of the Conservation Reserve Program (CRP) State Acres for Wildlife Enhancement (SAFE) Program on bird populations in Kansas. Kansas Department of Wildlife and Parks, $159,004.

Myrold, D., A. Jumpponen, P. Bottomley, N. Verberkmoyer, J. Jansson, and S. Tringe. 2010-2013. Meta-"omics" analysis of microbial carbon cycling responses to altered rainfall inputs in native prairie soils. DOE-BER, $563,729.

Sandercock, B.K., and M. Alfaro-Barrios. 2010. Seasonal components of demography of a migratory shorebird. KSU Institute for Grassland Studies, $14,000.

Sandercock, B.K., and A. Jumpponen. 2009-2012. REU Site: Ecology, evolution and genomics of grassland organisms. NSF REU Program, $210,720.

Sandercock, B.K., and S.M. Wisely. 2006-2010. Impacts of wind power development on the demography and population genetics of the Greater Prairie-chicken. National Wind Coordinating Committee (Sponsors include: Department of Energy - National Renewable Energy Laboratory, Kansas Department of Wildlife and Parks, State Chapters of The Nature Conservancy and 4 industry partners), $730,100.

Sandercock, B.K., and S.M. Wisely. 2009-2011. Environmental impacts of wind power development on population biology of Greater Prairie-Chickens. U.S. Department of Energy, 20% Wind Energy by 2030 Program, $299,998.

Smith, M.D. and C. Chang. 2010-2011. Dissertation Research: The relative importance of species, genotype, and trait diversity on ecosystem function of the tall grass prairie under varying environmental conditions. NSF, $14,877.

Smith, M.D., A.K. Knapp, S. Collins, and J.M. Blair. 2009-2012. Convergence and contingencies in savanna grasslands (renewal). NSF, $807,000.

Whiles, M.R. 2008-2010. Ecological integrity of prairie streams as influenced by patch-burn grazing and riparian protection. Missouri Department of Conservation, $131,836 (SIU portion).

Whiles, M.R., W.K. Dodds, and S. Johnson. 2010-11. Workshop: Use of ^{15}N tracer addition datasets to quantify and synthesize relationships between stream biodiversity and ecosystem function across environmental and hydrologic gradients. NSF Ecosystems program, $47,790.

Wilcox, B., S. Archer, J. Briggs, D. Elmore, S. Fuhlendorf, W. Polley, C. Hart and B. Wu. 2010-2011. Sustaining rangelands in the southern Great Plains in the 21st Century: Adapting to and mitigating for climate change. USDA AFRI Competitive Grants Program, $50,000.

Wisely, S.M. and A. Jumpponen. 2011-2016. Undergraduate research and mentoring in ecological genomics. NSF Biological Infrastructure, $749,919.

Wisely, S.M., and B. K. Sandercock. 2007-2010. Effects of wind power on Prairie Chickens. National Fish and Wildlife Foundation, $149,546.

Wisely, S.M., and B.K. Sandercock. 2009-2011. Environmental impacts of wind power development on population biology of Greater Prairie-Chickens. State Wildlife Grants Program, Kansas Department of Wildlife and Parks, $145,150

Zolnerowich, G., C. J. Ferguson, D. Allen and M. Haddock. 2007-2010. The K-State prairie plant and insect collection: elevating biodiversity and bioinformatics to the next level. KSU Provost's Targeted Excellence Program, $800,000.

Konza Prairie Research Findings:
Here we present a selected subset of recent results from the Konza Prairie LTER Program, and a complete list of publications findings for the 2010-11 year period.

Plant Community and Ecosystem Responses to Long-term Fire and Grazing Treatments, and Environmental Heterogeneity.
Three decades of study of vegetation dynamics on tallgrass prairie (LTER datasets PAB01-03, PVC01-02, and numerous supporting studies) have demonstrated that tallgrass prairie plant communities are characterized by: 1) high inter-annual variability in NPP; 2) high resilience to chronic grazing; 3) strong fire x grazing interactions that regulate plant species composition, relative abundances, diversity; and a high degree of spatial heterogeneity and temporal dynamics driven by fire, grazing, and topoedaphic variability.

Though grazing and fire have some comparable effects on ecosystem processes in grasslands, their effects on plant species composition and community structure can be quite different. Several recent studies have focused on the potential importance of specific plant traits as drivers of plant community dynamics and responses to environmental heterogeneity and environmental change. For example, an NCEAS working group (formed as part of an NCEAS Distributed Graduate Seminar research project led by Scott Collins) used 22 years of species composition data from the Konza LTER program to test if trait composition between grazed and burned grassland communities converged over time, and if the degree of convergence depended on fire frequency (Spasojevic *et al.* 2010). Additionally, they tested if eliminating fire from sites with a history of annual burning (the LTER Fire Reversal Experiment) would result in a convergence with unburned grassland communities and, conversely, if restoring fire to a long-term unburned grassland would cause composition to become more similar to that of annually burned grassland. Their analyses show that plant communities that were either grazed by bison or burned once every four years showed the most convergence in traits, suggesting that these communities operate under similar deterministic assembly rules, and that periodic recurring fire and herbivory act as similar disturbances to grasslands at the trait-group level of organization. Three years after reversal of the fire treatments we found that fire reversal had different effects depending on the initial community state. The formerly unburned community that was then burned annually became more similar to the annually burned community in trait composition, suggesting that plant community composition typical of frequently burned grasslands may be rapidly restored if fire is reintroduced. This has important implications for grasslands undergoing woody plant encroachment following extended fire suppression. Conversely, when fires were excluded from the annually burned community, trait composition developed along a unique trajectory indicating hysteresis, or a time lag for structure and function to return following a change in this disturbance regime. In total, these results indicate that initial conditions are important determinants of trajectories of change in response to altered disturbance regimes, and that functional traits and species-based metrics should be considered when determining and evaluating goals for fire management in mesic grassland ecosystems.

In another study, Craine, Nippert and students assessed the relationships among seleted plant functional traits and the distribution and abundance of species across a range of environmental conditions created by the large-scale fire and grazing experimental design at Konza Prairie (uplands/lowlands, grazed and ungrazed watersheds, and frequently and infrequently burned watersheds). Plant functional traits determine the performance of species in different environments, as many leaf functional traits are directly related to plant carbon gain as well as water and nutrient loss in different environments. Understanding the coupling between plant functional traits and abundance provides insight into the often hidden forces that structure plant communities. To better

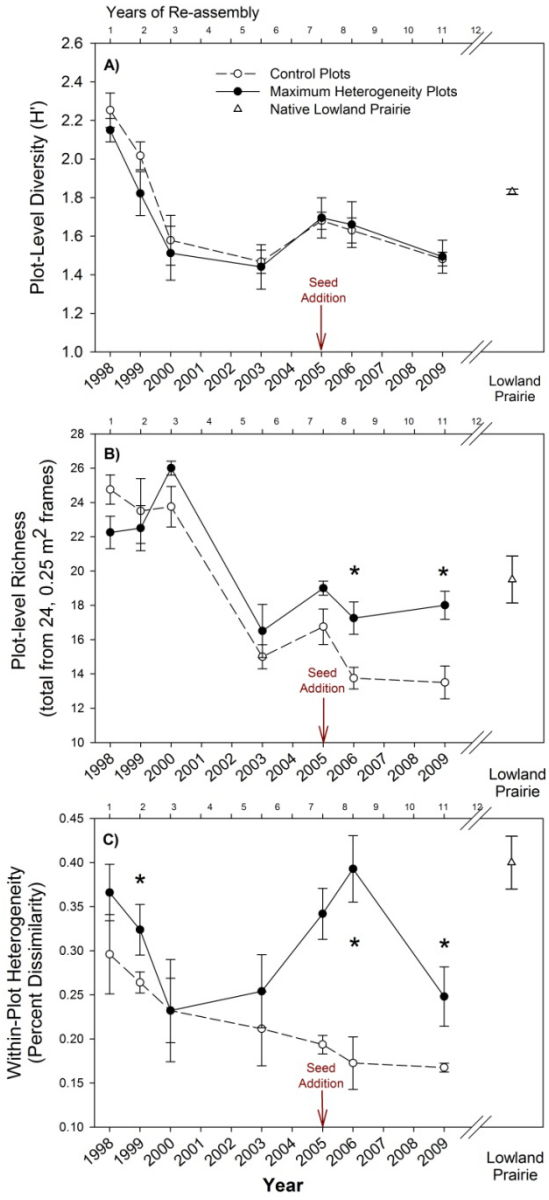
understand the coupling between leaf traits and abundance of grassland species in tallgrass prairie, Craine et al. (2010) measured specific leaf area (SLA) and its two components, tissue density and thickness for 125 grassland species. Plants with high tissue density were more abundant over a 17-year period across a range of environments: uplands, grazed and ungrazed watersheds, and frequently and infrequently burned watersheds. The consistent relationships between leaf tissue density and abundance across ecological contrasts imply that belowground resource availability constrains community composition independent of grazing and burning regimes. Leaf tissue density did not explain species abundance in lowlands, where belowground resources are the highest. Neither did it explain the differential abundance of species between grazing or fire frequency contrasts, suggesting that changes in burning or grazing select for species based on other traits.

Finally, Tucker et al. (2011) characterized physiological drought tolerance (Wcrit) for a large number of tallgrass prairie plant species found at Konza Prairie. They examined the relationships between Wcrit and a number of other key functional traits, and used a 17-year LTER dataset on plant species composition to test whether physiological tolerance of drought underlay species occurrence across a number of ecological contrasts, including topographic position, fire frequency, and presence/absence of grazing. Measured physiological drought tolerance of Konza species covered almost the full range known to plants globally. Consistently, physiologically drought-tolerant species had thin roots, while associations with other traits were inconsistent across functional groups. In this mesic grassland, physiological drought tolerance appears to increase the abundance of plants in xeric uplands, but not in the more mesic lowlands. Physiological drought tolerance did not alter species responses to changes in burning or grazing. In contrast to Wcrit, species with high root tissue density were more abundant in uplands and lowlands than species with low root tissue density, irrespective of grazing or burning regimes. Somewhat surprisingly, drought-tolerance appears to have a limited role in structuring contemporary plant communities in tallgrass prairie. However, more severe or frequent droughts in the region, as occurred historically and have been predicted to increase as a result of climate change, would likely restructure the Konza plant community in ways that are currently not observable.

Grassland Restoration Studies.

Two ongoing, long-term field experiments in LTER VI at Konza Prairie and a regional study have helped elucidated factors that constrain species diversity and recovery of ecosystem properties and processes during grassland restoration. The first restoration field experiment (initiated in 1997) was established to test whether environmental heterogeneity can promote restoration of species diversity. Replicated plots that vary with respect to heterogeneity in soil nutrient availability and depth have been maintained and produced one of the longest temporal datasets on community and ecosystem change during restoration that has been used to test basic ecological principles (Baer et al. 2003, 2004, 2005; Baer and Blair 2008). In 2009, we began to synthesize changes in plant community structure during the first 12 years of restoration (S. Baer, unpublished data). This long term dataset demonstrates a consistent and indiscriminate decline in plant diversity among the heterogeneity treatments over time. The maximum heterogeneity plots have maintained more species, but with negligible cover, than the control plots over the long term, which explains similar temporal patterns in diversity despite differences in richness among contrasting heterogeneity treatments. Plant community structure has responded to the heterogeneity treatments over the long term in that maximum heterogeneity plots show greater temporal and spatial variation in composition (percent dissimilarity) over time. The second restoration experiment established at Konza Prairie and replicated in Illinois, examines the role of population source of dominant species (cultivars or non-cultivars of the native grasses) and seed mix diversity on community and ecosystem recovery. Soil and plant responses from the third field season were analyzed in 2009 and indicate that population

source and dominance of the C_4 grasses influence soil N dynamics and microbial biomass inconsistently across the precipitation gradient due to differential patterns in the establishment of prairie vegetation between Konza and Illinois (R.P. Klopf dissertation, SIUC). Despite that we have documented intraspecific variation in root architecture and belowground net primary production (Klopf and Baer 2011), as well as in physiological performance (Lambert et al. 2011), between the population sources of the dominant grasses, greater ecosystem recovery in the Illinois site emphasizes that climate can modulate the degree to which biotic filters influence community and ecosystem recovery during restoration.



A regional study has demonstrated disparate patterns in recovery of soil carbon (C) and pools and fluxes as well as soil microbial community structure during grassland restoration on two highly contrasting soil textures (Bach et al. 2010, Baer et al. 2010). Total soil C (TC) and microbial biomass C (MBC) increased 21.2 and 5.7 g C m^{-2} y^{-1}, respectively, across a 19-year chronosequence of restored grasslands on silty clay loam soil. There was >600% increase in large macroaggregate C and 285% increase in soil aggregate mean weighted diameter (MWD) relative to cultivated silty clay loam soil within two decades of restoration. In contrast, there were no changes in soil C pools or soil structure across a 19-year chronosequence of restoration on loamy fine sand soil. Thus, the potential for restored agricultural lands to mitigate CO_2 emissions over the short term, in particular, cannot be generalized across all soils. Further, the extremely low restorative potential of loamy fine sand soil within two decades (relevant to many conservation programs) has implications for prioritizing preservation of remnant sand prairies (Baer et al. 2010).

Most restoration research findings from 2010-2011 have resulted from analysis of plant community composition and root biomass data collected in 2010. This restoration experiment contains whole plots seeded to either cultivar or locally-collected grass sources and each whole plot contains five subplot treatments of seeded grass dominance. The entire experimental framework is replicated in Belleville, Illinois, a more mesic region tallgrass prairie once occupied. Root biomass cores were sampled from the 20% and 97% seeded grass dominance subplot treatments. In Kansas, root biomass was greater in cultivar plots than non-cultivar plots ($P = 0.002$), but similar in the 20 and 97% grass dominance treatments. In Illinois, root biomass was similar in cultivar and non-cultivar plots, but root biomass was greater in the 97% grass treatment than in the 20% grass dominance treatment ($P = 0.070$). In both regions, total ANPP was not different in response to source or dominance treatments. Different response of root biomass to the two factors (source and dominance) in the two locations may be due to difference in climate. From 2005 to 2010, establishment and cover of dominant grasses were lower in Kansas non-cultivar plots, which in-part explained the lower

root biomass in non-cultivar plots in Kansas. In IL, the wetter climate likely enabled similar establishment of dominant species regardless of source, but resulted in greater root biomass in higher grass dominance treatments. More detailed analyses of plant community composition (2006-2010) demonstrated development of higher cover of grass cultivars in KS ($P = 0.005$), but indistinguishable cover between the two grass sources in IL by 2010. Shannon's diversity exhibited contrasting temporal dynamics over time between the two sites, with less variation over time in KS and a decline in diversity over time in IL (year effect: $P = 0.001$); Shannon's diversity converged at a similar level in both sites in 2010. Counter to the hypothesis that cultivars (selected for agronomic traits) would competitively suppress non-dominant species, diversity was similar to or higher in plots restored cultivars in both locations. These results will be presented at the annual meetings of the Ecological Society of America in Austin, TX.

Positive Feedback Mechanisms Drive Shrub Encroachment in Tallgrass Prairie.
In the last century, woody vegetation has expanded in grasslands and savannas worldwide, with impacts on carbon cycling and regional biodiversity. In the Flint Hills of northeastern Kansas, USA, the shrub *Corus drummondii* has expanded into the tallgrass prairie despite the maintenance of antecedent fire frequencies. To better understand dynamics and drivers of woody encroachment in tallgrass prairie, we established transects spanning the shrub – grass ecotone. Our results showed source water partitioning (using xylem-water δ^2H and $\delta^{18}O$) between *C. drummondii* and the C_4 grass *Andropogon gerardii*, with *C. drummondii* relying upon intra-annually stable soil water below 30 cm depth. Early summer canopy development reduced light availability at the ecotone, a response that favors woody vegetation over C_4 grasses. At the ecotone and shrub center, fine fuels decreased by ~50% after 4 years of growth minimizing the impact of subsequent fires on shrub biomass. These shrub-mediated changes represent positive feedback mechanisms that can drive subsequent *C. drummondii* expansion into the grassland matrix. These same changes may also facilitate woody seedling establishment. Because *C. drummondii* exhibits strong controls on ecosystem structure and its clones can avoid competition with grasses by accessing deep soil water sources, the ecological threshold for woody expansion in tallgrass prairies may be the event of woody establishment. Once established, the predominate woody encroacher of this region (*Cornus drummondii*) may bypass typical establishment barriers, resulting in a localized positive feedback loop. These shrubs expand radially into the grassland matrix via rhizatomous clones and we found that these developing stems utilize the same deep soil water source as their parent shrub (likely via rhizatomous transfer). The ability to access deep-water sources circumvents competition for water with grasses, a process that would otherwise restrict seedling establishment. Additionally, fine fuels declined exponentially at the shrub/grass interface, reducing the potential impacts of subsequent fires. The release from resource/fire limitation should result in a positive feedback system as clonal expansion allows individual shrubs to reach up to 200 m^2, compared to <1 m^2 as single-stemmed individuals. This interpretation is consistent with long-term data on site (26 years), where we found that the size of shrubs that are both clonal and deeply rooted has increased 16-fold and aerial coverage has increased from 0 to ~28%. In contrast, the cover of non-clonal species has remained the same and shallow-rooted clonal species have only increased marginally. Together, these results suggest that positive feedbacks facilitate woody encroachment in mesic tallgrass prairie, but by promoting the expansion of existing shrubs rather than the establishment of new individuals. The reduced competition for water and decreased intensity of fires following encroachment represents a reversal of the factors that maintain grass dominance, highlighting the likely possibility that tallgrass prairie is a bi-stable system. Therefore, any global change phenomena (land-use, increased CO_2, N-deposition) that facilitates or lowers resilience to initial woody establishment in grasslands, may lead to abrupt non-linear state-shifts in grassland ecosystems.

Bud Banks and Plant Population Dynamics
A recent Konza LTER study (N'Guessan and Hartnett *in press*) focused on the dominant grass *Shizachyrium scoparium* (little bluestem) demonstrated that, although this species lacks compensatory growth capacity, its belowground bud bank traits are key to explaining its persistence under frequent grazing. Specifically, the maintenance of a large pool of dormant buds across a wide range of grazing intensities, and the shift in bud position and plant architecture contributes to its grazing tolerance and grazing avoidance respectively. Ott and Hartnett (*in press*) showed that large interspecific differences in grass bud natality, longevity, and controls on dormancy and outgrowth can explain differences in grass population dynamics and predict their population resilience or sensitivity to environmental change, and ultimately plant community change. In addition, another study by Ott and Hartnett (*in press*) demonstrated that unique features of the modular construction of grasses and phylogenetic constraints explain patterns of seed and vegetative reproduction in grasses and the lack of a trade-off between these two modes of reproduction as predicted by life history theory. This study contributes to an increasing body of KNZ research indicating that meristems limitation as well as resource limitation is important to understanding plant population responses in grasslands. Our recently completed experiments in collaboration with Oklahoma State University (Wilson and students) also showed that light spectral quality (R:FR) is important in regulating bud dormancy and tiller activation in three of six grass species studied. Nitrogen resulted in species-specific responses, with each species responding differently to N amendments. This indicates that alterations in nitrogen availability, light availability, or shifts in spectral quality may affect grassland plant communities through differential demographic responses among grass species. Overall, these findings will lead to improved predictive models of grassland responses to environmental change.

Linking plant growth responses across topographic gradients in tallgrass prairie
Using a transect spanning a topographic gradient in annually-burned tallgrass prairie, Nippert et al. (2011) measured changes in the growth of four abundant C_4 grass species, LAI, biomass, and cumulative carbon flux using two closely located eddy flux towers. We hypothesized that responses along the topographic gradient could be partitioned into position descriptions (e.g., upland / lowland), and the magnitude of growth and carbon flux would vary as a function of topographic position, but the patterns across positions would be similar. Annual carbon flux was greater in lowland versus upland locations, indicating that the source areas contributing to tower fluxes varied. For most of the growth variables measured, a 4-position topographic classification based on soil depth was the best. The magnitude of biomass production, LAI and changes in plant growth varied, with increasing values from the lowland to slope to break and upland positions. Differences in growth by landscape position reflected the greater production of flowering culms by *Andropogon gerardii* and *Sorghastrum nutans* in lowland. Varying growth responses by these species may be a significant driver of biomass and carbon flux differences by topographic position, at least for wet years. These results suggest infrequent temporal or limited spatial sampling of plant growth, LAI, or biomass would contribute to a location bias and incompletely describe the turbulent carbon fluxes from this grassland. Thus, measuring the biological responses associated with small-scale landscape variability, and accounting for this variability should improve model predictions of carbon flux at larger scales.

Grassland Responses to Climatic Variability and Climate Change.
Several recent studies have utilized long-term data on plant productivity, ANPP and flowering culm production to assess specific climatic controls on grassland plant productivity (e.g., Nippert et al. 2006, Craine et al. 2010, La Pierre et al. 2011). Although these studies are invaluable for assessing plant community and ecosystem responses to contemporary climatic variability, the highly dynamic and complex responses of grasslands to climatic variability present a significant challenge for

forecasting responses to future climate change. Our climate change studies during LTER VI continue to focus on assessing responses to climatic variability and potential future climate change. Since 1998, we have manipulated rainfall amounts and timing (variability) to native prairie plots using Rainfall Manipulation Plots (RaMPs) (modified rainout shelters; Fay et al. 2000, 2003, *in press*) and other rainout shelter approaches (Heisler-White et al. 2009). Altered timing of rainfall events, with no change in total rainfall amount, has significant consequences from the physiology of individual plants to ecosystem C fluxes (Knapp et al. 2002, Fay et al. 2003, Harper et al. 2005, Fay et al. 2008, Nippert et al. 2009). Similar manipulations across a regional precipitation gradient indicate that these effects vary for mesic and arid grasslands, highlighting the importance of conducting climate change experiments under a range of ambient climatic conditions (Heisler-White et al. 2009). The RaMPs project, and related climate change studies at Konza Prairie have garnered increasing national and international recognition, as demonstrated by the participation of Konza LTER scientists in several recent international meetings and workshops on climate change research (TERRAC EPRECOT Precipitation workshop, Elsinore, Denmark, May 22-25 2006; European Geophysical Union, Vienna, Austria, April 2006; Ecological Society of America, San Jose, CA, August 8 2007; International Water Expo in international Water Expo, Zaragoza, Spain, July 21-23 2008; Regional and Global Network of Grassland Ecosystem Research: Issues and Perspectives, August 12-14 2009, Beijing, China; Ecological Society of America, Pittsburgh, PA, August 2010).

At the regional scale, changing climate could affect the functioning of grassland ecosystems through variation in climate forcings and by altering the interactions of forcings with ecological processes. Both the short and long-term effects of changing forcings and ecosystem interactions are a critical part of future impacts to ecosystem ecology and hydrology. To explore these interactions and identify possible characteristics of climate change impacts to mesic grasslands, Petrie et al. (2011) employed a low dimensional modeling framework to assess the IPCC A1B scenario projections for the Central Plains of the United States; forcings include increased precipitation variability, increased potential evaporation, and earlier growing season onset. These forcings are also evaluated by simulations of vegetation photosynthetic capacity to explore the seasonal characteristics of the vegetation carbon assimilation response for species at the Konza Prairie. The climate change simulations show decreases in mean annual soil moisture and carbon assimilation and increased variation in water and carbon fluxes during the growing season. Simulations of the vegetation response show increased variation at the species-level instead of at a larger class scale, with important heterogeneity in how individual species respond to climate forcings. Understanding the drivers and relationships behind these ecosystem responses is important for understanding the likely scale of climate change impacts and for exploring the mechanisms shaping growing season dynamics in grassland ecosystems.

During LTER VI, we also are continuing new experiments to assess stream responses to increased hydrologic variability (flood and drought) related to climate change. We developed an experimental stream facility to run replicated experiments at realistic spatial and temporal scales (Matthews et al. 2006), and supported new research on predator-prey relations (Knight and Gido 2005) and responses of stream communities and ecosystems to varying frequency and/or intensity of floods and drought (Bertrand and Gido 2007, Murdock and Dodds 2007, Murdock et al. 2010, 2011, Kohler et al. 2011). Results of these studies are highlighted under in the *Stream Research* section of this report.

While future climate changes will undoubtedly affect grasslands, current environmental variability drives contemporary landscape patterns in species occurrence and abundance, and a significant effort is focused on assessing the influence of environmental variability on the processes underlying carbon cycling in these grasslands. Research on carbon dynamics along a heterogeneous topographic gradient in annually-burned tallgrass prairie is being led by Jesse Nippert and Nate Brunsell. Carbon

flux dynamics in grassland systems vary according to landscape gradients in resource availability and temporal patterns of growth. Accounting for spatial and temporal variability in growth at small scales should improve model predictions of carbon flux at larger scales. Using a transect spanning a topographic gradient in annually-burned tallgrass prairie, we measured changes in the growth of four abundant C_4 grass species, LAI, biomass, and cumulative carbon flux using two closely located eddy flux towers. We hypothesized that responses along the topographic gradient could be partitioned into position descriptions (e.g., upland / lowland), and the magnitude of growth and carbon flux would vary as a function of topographic position, but the patterns across positions would be similar. Annual carbon flux was greater in lowland versus upland locations, indicating that the source areas contributing to tower fluxes varied. For most of the growth variables measured, a 4-position topographic classification based on soil depth was the best. The magnitude of biomass production, LAI and changes in plant growth varied, with increasing values from the lowland to slope to break and upland positions. Differences in growth by landscape position reflected the greater production of flowering culms by *Andropogon gerardii* and *Sorghastrum nutans* in lowland. Varying growth responses by these species may be a significant driver of biomass and carbon flux differences by topographic position, at least for wet years. These results suggest infrequent temporal or limited spatial sampling of plant growth, LAI, or biomass would contribute to a location bias and incompletely describe the turbulent carbon fluxes from this grassland. Thus, measuring the biological responses associated with small-scale landscape variability, and accounting for this variability should improve model predictions of carbon flux at larger scales.

Climate change signals and responses to changing habitats also affect the dynamics of grassland consumers (Rehmeier et al. 2005, Sandercock 2006, Reed et al. 2007, Jonas and Joern 2007, Sandercock et al. 2008), underscoring the need for an integrative approach to climate change studies. In a recent paper (Craine et al. 2009), bison weights on Konza were analyzed for a 14 years period and related to plant productivity and climatic drivers. Greater late-summer precipitation increased bison weight gain, yet greater midsummer precipitation decreased weight gain. The decreased weight gain of bison with greater midsummer precipitation was associated with increased grass stem production during the period for each of three dominant grasses at Konza Prairie. With offsetting effects of mid- and late-summer precipitation on weight gain, these results show that predicting the effects of climate change on grazers must incorporate both the timing and magnitude of changes in precipitation and their effects on both the quantity and quality of biomass.

Species interactions are also influenced by the environmental context, but we do not yet have a clear understanding of how biotic and abiotic components of the environment combine to affect species interactions. Using a plant-grasshopper-spider food chain as a model system, we are conducting large field experiments examining how abiotic (morning temperature) and biotic (food quality, herbivore density, predation) factors affect grasshopper performance and predator-prey interactions. Results from last season show that predator-prey interactions and the occurrence of trophic cascades shift with temperature. Predator effects appear to be enhanced when morning temperatures are reduced, and diminished when morning temperatures are increased. In shaded treatments, spiders have strong negative effects on grasshopper survival and body size, and grasshoppers feed less. This strengthening of predator effects leads to a trophic cascade in plant biomass. Alternatively, when morning temperatures are increased, spider presence has no effect on grasshopper survival, body size, or feeding. The warmed treatments effectively remove the effects of predators on the grasshoppers, and no trophic cascade is observed. These data demonstrate the importance of the environmental context for influencing species interactions, and the importance of temperature in particular for driving invertebrate species interactions.

The Ecology of Tallgrass Prairie Streams

Recent LTER research has documented how consumers alter the trajectory of ecosystem functional and structural recovery following flooding and drying that commonly occurs in prairie streams (Bertrand et al. 2009, Murdock et al. 2010, Murdock et al. 2011). These data suggest that human influences of nutrient pollution and alteration of large consumer communities both change the fundamental properties of prairie stream ecosystems. We have found that riparian vegetation might fundamentally alter downstream phosphorus transport (Banner et al. 2009). Prairie aquatic systems are clearly demonstrated to be vulnerable to threshold effects (Evans-White et al. 2009, Dodds et. al. 2010, Gido et al. 2010).

We completed most data analyses on a small scale (stream reach scale) woody vegetation removal experiment where we have documented that vegetation removal (restoration to natural riparian conditions of grassland streams) lead to 1) increased denitrification rates (Reisinger 2010), 2) shifts in communities with fewer leaves and bryophytes, and more filamentous algae, 3) corresponding shifts in ecosystem metabolism related to more light reaching the stream and less detrital leaf materials (Riley 2011), and 4) corresponding changes in invertebrate communities related to changes in food availability. J . Vandermyde (MS student at SIU) found that stream macroinvertebrates responded significantly to the vegetation removal, with increases in grazers and most other functional groups. However, after one year, invertebrate communities still differed significantly from those in naturally open reaches. All analyses of invertebrate responses will be completed in fall, 2011.

Continued participation in the LINX II (Lotic Intersite Nitrogen eXperiment II) and resulted in a publication documenting freshwater streams and rivers are a substantially more important source of nitrous oxide than previously thought (Beaulieu et al. 2011) and that denitrification in headwater streams can occur at close to potential rates, making them an important site of nitrogen removal (Findlay et al. 2011).

Dan Whiting completed his MS research at SIU examining longitudinal patterns of macroinvertebrate community structure and production along a prairie stream continuum from grassy headwaters to gallery forest (Whiting et al. 2011). Results indicate that communities do respond to changing energy inputs along the gradient and that benthic organic matter resource availability along the continuum is a function of riparian vegetation and hydrology. Results also suggest that biotic interactions can significantly influence patterns of community structure and productivity.

Final analysis and publication of two mesocosm studies was completed in 2011. The first paper described the effects of a grazing minnow and nutrient loading on periphyton stoichiometry (Kohler et al. 2011). In this study we found that both the presence of consumers and nitrogen additions caused a reduction of C:N ratios of periphyton. Because lower C:N ratios indicate higher forage quality, these results suggest that consumers and nutrients are likely to influence the transfer of energy and nutrients in stream food webs. In a second study, Reisinger et al. (in press) tested the role of a grazing minnow on denitrification rates in prairie streams. Although grazing minnows were found to influence structural properties of benthic communities, they were not shown to influence denitrification rates. Preliminary results from a mesocosm study conducted in summer 2010 indicate effects of consumers on ecosystem properties varies by consumer species and that combinations of species can result in additive effects. Final processing of samples and data analysis is expected in fall 2011.

Konza Prairie Groundwater Studies.
A regional flow model that includes the Konza LTER site (Steward et al., 2011) shows the recharge and discharge areas and the involvement of streams in groundwater. Data analysis of Tsypin's thesis project shows a short but measureable lag time between chemical and isotopic parameters measured in the soil and those in shallow groundwater, including supporting evidence for downward flux of soil CO_2 to groundwater (Tsypin et al., 2010; and manuscript in progress), which is significant in light of the long-term increase in groundwater CO_2 documented at Konza (Macpherson et al., 2008). Preliminary data from the rapid-snowmelt-event project shows levels of nitrate and potassium (macronutrients) in throughflow during the two sampled RSE's to be significantly higher than has ever been measured in groundwater or streamwater at Konza, suggesting the RSE's rob the soil of these nutrients. Micronutrients (B, Co, Ni, Cu, Zn, Mo) in RSE throughflow water are also detectable, but comparisons cannot yet be made with groundwater and surface water chemistry because these elements have not been measured. Sequential chemical extraction data of soils shows that the rare earth elements in the easily exchangeable fraction are different from those in other extracts. This is not explained by differential aqueous complexation in the soil-water environment, and suggests the exchangeable ions reflect a source different from the bulk of the soil (Macpherson, manuscript in progress). In addition, the distribution of certain elements important to microbial functioning, such Cu, increase in concentration on the organic matter fraction of the soil with depth, showing that Cu released during organic matter degradation is quickly re-sorbed onto remaining organic matter, thus possibly limiting its bioavailability (Macpherson, manuscript in progress). A small increase in the *rate* of chemical weathering at the Konza LTER is interpreted from the long-term major-element chemistry data set, despite the strong dependence of chemical weathering rates on the highly variable annual stream discharge (Macpherson, 2011; and manuscript in progress).

Mycorrhizal Ecology.
Previous Konza Prairie studies have shown that the mutualistic symbioses between plants and arbuscular mycorrhizal (AM) fungi have large effects on plant population dynamics, competition, community composition and diversity, and responses to fire and grazing. An overview of mycorrhizal ecology in grasslands was the focus of a recently accepted book chapter Arbuscular Mycorrhizas and Grassland Ecosystems (R.M. Miller, G.W.T. Wilson, and N.C. Johnson) for Plant Fungal Interactions; Editor: D. Southwood. Wiley-Blackwell; in Press). This chapter discusses mycorrhizal research from KPBS, Cedar Creek, Fermi, and African grasslands. Recent studies with partial support from LTER funding and conducted, at least in part, on Konza prairie Biological Station have been focusing on the role of mycorrhizae on grassland invasibility, nutrient uptake, soils, and ecosystem processes.

Mycorrhizae and resource use/allocation: Research in collaboration with colleagues at Northern Arizona University (N.C. Johnson) and Argonne National Laboratory (R.M. Miller) has demonstrated that AM fungi improve soil structure and are important carbon sinks. For example, we have shown that AM fungi produced up to 87% more hyphae in their home soil. Thus, locally adapted fungi have the potential to sequester more carbon and nutrients in their hyphae than non-adapted fungi (published in PNAS 2010; 107: 2093-2098). Our results indicate that AM fungi increase uptake of the nutrient that is most limiting in the soil. Further, we show that *Andropogon* ecotypes adapt to their local soil and to AM fungal communities such that mycorrhizal resource exchange of the most limiting resource is maximized. Wilson presented these data at Ecological Society of America (2010).

We recently generated the full spectrum of mycorrhizal functioning from mutualism to parasitism through manipulating C, N, and P availability using cross-site comparisons and within site

fertilization (N.C. Johnson, G.W.T. Wilson, and R.M. Miller – submitted to Ecology Letters). Our cross-site locations were Konza Prairie Biological Station, Cedar Creek LTER, and Fermi Prairie (Argonne National Laboratory). Results of our experiments provide strong support that P-for-C trade can directly control of mycorrhizal function through equal exchange mechanisms, while N availability indirectly control mycorrhizal function through its effects on C supply and C demand. These results may be a useful guide for fertilizer management to enhance mycorrhizal benefits in grassland restoration, and help develop testable hypotheses of mechanisms by which resources control AM function.

Mycorrhizae and grassland restoration: Warm-season (C_4) grasses often become dominant during tallgrass prairie restorations leading to overall low richness and diversity in this ecosystem. These dominant grasses are strongly mycotrophic, while many subordinate forb species are less dependent on mycorrhizal symbiosis. Therefore, manipulating arbuscular mycorrhizal fungi (AMF) may be useful in promoting establishment and growth of forb species in grass-dominated tallgrass prairie restorations. To assess the potential role of mycorrhizae in affecting the productivity and community composition of restored tallgrass prairie, we conducted a 4-year field experiment on an 8 year-old grassland restoration at Konza Prairie. Four years of mycorrhizal suppression reduced productivity of the dominant grasses and increased both plant species richness and diversity. These results highlight the importance of mycorrhizae as mediators of plant productivity and community dynamics in restored tallgrass prairie, and indicate that temporarily suppressing AMF decreases productivity of the dominant C_4 grasses and allows for establishment of seeded forb species. These results were recently accepted for publication in Plant Ecology (K.N.S. McCain, G.W.T. Wilson, and J.M. Blair, In Press).

Research in collaboration with colleagues at Northern Arizona University and Argonne National Laboratory has provided solid evidence that co-adapted plants and AM fungi develop over time such that the fitness of both plants and fungi is maximized under local soil conditions (published in PNAS 2010; 107: 2093-2098). Therefore, when establishing restoration practices selection of native inoculum and local plants species is critical.

Mycorrhizae and invasive grasses: Understanding how mycorrhizal associations are affected by plant invasions may be a critical aspect of the conservation and restoration of native ecosystems. G.W.T Wilson, K.R. Hickman, and M.M. Williamson (Mycorrhiza *in press*) examined the competitive ability of old world bluestem, a non-native grass (*Bothriochloa bladhii*), and the influence of *Bothriochloa* competition on AM root colonization of native warm-season prairie grasses (*Andropogon gerardii* or *Schizachyrium scoparium*). Competition by the non-native resulted in significantly reduced biomass production and AM colonization of the native grasses. To assess plant-soil feedbacks of *Bothriochloa spp.*, a second greenhouse study examined soil alterations indirectly by assessing biomass production and AM colonization of native warm-season grasses planted into soil collected beneath *Bothriochloa spp*. This study was conducted using soil from four replicate prairie sites throughout Kansas (KPBS and Fort hays State University) and Oklahoma (OSU Stillwater Range Research and Klemme Range Research Stations). Our results indicate a major mechanism in plant growth suppression following invasion by *Bothriochloa spp.* is the alteration in soil microbial communities. Plant growth was tightly correlated with AM root colonization demonstrating mycorrhizae play an important role in the invasion of these systems by *Bothriochloa spp.* and indicating restoration of native AM fungal communities may be a fundamental consideration for the successful establishment of native grasses into invaded sites. Wilson presented these data at Botanical Society of America (2011). Wilson's OSU PhD student (Mitch Greer) is expanding this research assessing plant-microbial feedbacks of invasive non-native warm-season

grasses. Greer's research involves multiple field sites throughout Nebraska, Kansas, Oklahoma, and Texas.

Mycorrhizae and soil carbon sequestration: Plant roots and mycorrhizas are conduits between atmospheric carbon dioxide and soil organic carbon. Consequently, a better understanding of AM ecology and discovery of mechanistic linkages between the structure of mycorrhizas and their symbiotic and ecosystem functioning will advance our understanding of soil carbon dynamics. Gail Wilson (Oklahoma State University), Nancy Johnson (Northern Arizona University), and Mike Miller (Argonne National Laboratory) are incorporating multiple data sets from field and greenhouse mycorrhizal studies of North American grasslands to test the hypothesis that production of AM fungal hyphae will increase storage of soil organic carbon. We have shown that AM fungi produced up to 87% more hyphae in their local soil. Thus, locally adapted fungi have the potential to sequester more carbon and nutrients in their hyphae than non-adapted fungi. Several of our studies show that burning and fertilizer management practices influence densities of AM fungal hyphae. In addition to AM hyphal biomass inputs to the soil carbon pool, the hyphae help create a physical framework for stabilizing primary soil particles into larger soil aggregates. As soil aggregation is thought to protect C rich detritus from microbial degradation, increased aggregate stability could increase C sequestration. This is important to consider when designing management strategies to maximize belowground carbon sequestration because AM fungi comprise a large and potentially very important belowground carbon sink.

Ecology of Fungal Communities.
Jumpponen and colleagues continue the development and application of the next-generation high throughput sequencing to query fungal communities in various environments. These analyses have indicated that fungal communities shift following a vertical gradient in native prairie soils and that some fungal taxa are more common in or nearly exclusive to soil horizons up to 1m in depth (Jumpponen et al. 2010a). Pure-culturing, metagenomic, metatranscriptomic, and/or metaproteomic analyses are necessary to further elucidate the function of these fungi. Two distinct research projects (Jumpponen et al 2010b, Jumpponen 2011) focusing on seasonal dynamics of fungi associated with roots of the dominant prairie grass, *Andropogon gerardii,* and the common bur oak, *Quercus macrocarpa,* both indicate that fungal communities shift in both structure and function in the course of a growing season. Although the fungal communities colonizing the roots of the two hosts are distinct, they both include a large saprobic component early in the growing season. This saprobic community is replaced by arbuscular mycorrhizae in *Andropogon* and ectomycorrhizal fungi in *Quercus* suggesting a similar broad functional shift in these communities.

Studies of fungal communities that inhabit oaks in urban and native stands indicated that both phyllosphere and rhizosphere communities are hyperdiverse (~1,000 taxa), distinct among the urban and native stands (Jumpponen & Jones 2009, Jumpponen et ala 2010a) and seasonally dynamic (Jumpponen & Jones 2010, Jumpponen et al. 2010a). In collaboration with research groups in Department of Statistics at KSU and Institute of Botany and Landscape Ecology, University of Greifswald in Germany, we aimed to build approaches that would permit identification of the primary assembly drivers of these communities (Jumpponen et al 2010c) as well as to evaluate how the next generation sequencing data follow commonly used models for species abundance distributions (Unterseher et al. 2011). These analyses suggest that broad environmental data matrices are a poor source for identification of environmental correlates for commonly occurring molecular taxa because of the low frequencies (Jumpponen et al. 2010c) and that usual species abundance models apply well in systems characterized by low taxon richness but fail to do so for hyperdiverse

communities (Unterseher et al. 2011). Our goal is to continue these fruitful collaborations to explore the utility of the next-generation sequencing data for queries of microbial communities.

Population Ecology of Grassland Birds

In 2009-2010, Sandercock was on sabbatical leave at the Norwegian Institute of Nature Research (NINA) in Trondheim, Norway. Research output from long-term population studies of grassland birds at Konza Prairie by Sandercock and his research group included an edited book with five peer-reviewed book chapters and two research articles. Sandercock and two coeditors completed an edited book on the ecology of grouse that will include 25 chapters by 70 contributors. Five chapters were based on research at prairie chickens at Konza Prairie and other sites in the Flint Hills. Gregory et al. (2011) reports on spatial modeling used to identify lek locations and habitat requirements of prairie chickens at a regional scale. McNew et al. (2011c) examined the long-term data on prairie chickens from Konza and found that declining occupancy was due to woody encroachment and fire frequency. Augustine and Sandercock (2011) and McNew et al. (2011a, 2011b) examined effects of rangeland management on reproductive rates and survival and show that intensive land management results in low productivity, with potential for evolutionary changes in reproductive effort. Last, Augustine et al. (2011) describes results of a field experiment where testosterone implants were used to investigate male behavior and female choice. A 9-year genetic study of the mating system of Upland Sandpipers revealed the highest rates of extra-pair mating yet reported among socially monogamous species of shorebirds (30% of broods and 15% of young, Casey et al. 2011). High rates of multiple mating were not related to genetic similarity among mated pairs, and did not increase genetic diversity among the young. However, a spatial genetic autocorrelation analysis revealed unexpected patterns of relatedness among females nesting <1 km apart. Female-biased natal philopatry is unusual among birds but is nevertheless consistent with the mate defense mating system of Upland Sandpipers. Toxicological sampling of Upland Sandpipers at Konza Prairie and agricultural lands in central flyways indicated that exposure to cholinesterase-inhibiting insecticides is not a major factor in ongoing population declines of this migratory species (Strum et al. 2010).

Small Mammal Population Dynamics.

Konza LTER research on small population dynamics is being led by Don and Glennis Kaufman and students. Their studies of small mammal populations spans nearly 30 years and multiple land-use and land-cover types at the Konza LTER site. Here we summarize the results of two recent studies.

Hispid pocket mice (*Chaetodipus hispidus*) are found from the grasslands of Great Plains to the deserts of the southwest, but little is known about this species in native tallgrass prairie at the eastern edge of its range. Our long term studies (Kaufman et al. *submitted*) in combination with shorter term studies on Konza Prairie show that hispid pocket mice are extremely uncommon in tallgrass prairie (only 3 individuals captured per 10,000 trap nights). Hispid pocket mice were more likely to be captured in autumn and summer than in spring. Males emerged from torpor in spring before females, whereas females entered torpor later in autumn. Abundance of hispid pocket mice varied temporally across the 30 years. In contrast to our previous studies that showed a negative effect of low precipitation (e.g., short-tailed shrews; Matlack et al. 2002), January-September precipitation had a tight limiting effect on maximal number of individuals that was present (i.e., for ~135 mm of added precipitation, 1 potential individual was lost). Therefore, with the expected decrease in rainfall with climate change, hispid pocket mice would be expected to increase in number. Hispid pocket mice were more common on slope prairie than on upland or lowland prairie, but burning and grazing had no effect. The spatiotemporal distribution of hispid pocket mice in autumn showed an "anti-nested" distribution with no focal years or sites. Finally, our study illustrates the importance of long-term data sets, especially in the study of uncommon to rare species.

With the discovery of the deer mouse (*Peromyscus maniculatus*) as the major reservoir of Sin Nombre virus (a hantavirus that causes hantavirus pulmonary syndrome, which has a high mortality rate in humans), Institutional Animal Care and Use Committee (IACUC) regulations now require that all traps that have captured small mammals be disinfected. We examined whether chronic exposure of traps to disinfectant reduced trappability of rodents as compared to new traps (Kaufman et al. 2011). We tested whether rodents initially chose between treated (disinfected) and new traps and if total number of captures differed between these treatments. Disinfectant did not reduce catchability of traps; rodents actually preferred treated traps. In initial pair-wise choice tests, rodents overall and the predominant deer mouse chose significantly more treated than new traps, although this difference disappeared as time of exposure of new traps in the environment increased. Total captures of small mammals and deer mice did not differ between treated and new traps. Therefore, treated traps were never avoided; this has important implications in general, but especially for long-term studies where censuses were conducted using pre-disinfectant and post-disinfectant protocols.

Cross-Site, Synthesis and Network-level Studies.
Konza LTER scientists continue to be active in studies and synthetic analyses that extend beyond the border of the Konza Prairie site. For example, Konza LTER scientists in the aquatic group participated in the LINX II cross-site nitrogen tracer experiments to assess factors controlling retention and release of nitrate in stream ecosystems. Results of these studies were published in Nature (Mulholland et al. 2008) and Limnology and Oceonography (Mulholland *et al.* 2009, Hall et al. 2009), indicating that efficiency of nitrogen removal decreases as nitrogen loading increases. Other recent cross-site and synthetic publications included patterns and controls of plant community dynamics (Chalcraft *et al.* 2008, Cleland *et al.* 2008), applications of phenological studies to assess 21st century climate change (Morrisette *et al*. 2009), synthetic review of the impacts of climate change on terrestrial ecosystems (Garrett *et al.* 2008, Marshall *et al.* 2008, Gerten *et al.* 2008, Luo *et al.*2008), a synthetic review of non-target and invasive species in restored ecosystems (Baer et al. *in press*), a synthetic comparison of the value of ecosystem goods and services in native and restored ecosystems (Dodds et al. 2008), and a new conceptual framework for assessing ecosystem responses to chronic resource alterations induced by global changes (Smith *et al. in press*).

Konza investigator Harrington and undergraduate student Tom Prebyl co-authored a paper (York et al. *in press*) based on a cross-site LTER SBE supplement. They compiled and analyzed land fragmentation trends from 1992 to 2001 in Manhattan, KS, along with four southwestern cities associated with LTER sites. All five sites are affected by agricultural to urban conversion. The group found two general fragmentation trends: expansion of the urbanized area leading to fragmentation in the exurban and peri-urban regions and decreased fragmentation associated with infill in the previously developed urban areas. They identified three fragmentation patterns (riparian, polycentric, and monocentric) associated with recent growth and urbanization, and identified five relevant drivers (water provisioning, population dynamics, transportation, topography, and institutions) that shape land use decision-making and fragmentation in the mid- and south-west. At all five sites, damming major rivers for storage or flood control, coupled with prior appropriation laws, strongly affected land use.

Below is a list of Konza Prairie LTER publications for the period January 2010 – present (August1, 2011).

Publications - 2010

Apple J., T. Grace, A. Joern, P. St. Amand, and S.M. Wisely. 2010. Comparative genome scan detects host-related divergent selection in the grasshopper *Hesperotettix viridis*. Molecular Ecology **19**: 4012-4028.

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Jumpponen, A. and K.L. Jones. 2010. Seasonally dynamic fungal communities in Quercus macrocarpa phyllosphere differ among urban and nonurban environments. New Phytologist **186**: 496-513.

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