

Annual Report for Period: 11/2009 - 10/2010

Submitted on: 08/17/2010

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 long-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 riparian 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 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: Komatsu, 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, Jacqueline

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: Brown, Shawn

Worked for more than 160 Hours: Yes

Contribution to Project:

Project yet to be determined (Advisor: Ari Jumpponen).

Name: Hartman, Jeffrey

Worked for more than 160 Hours: Yes

Contribution to Project:

MS student working with Dr. Jesse Nippert.

Name: Ratajzak, Zak

Worked for more than 160 Hours: Yes

Contribution to Project:

PhD student working with Dr. Jesse Nippert.

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: Tsy-pin, 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).

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: Orłowski, 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: 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: Sonnentag, Tammy

Worked for more than 160 Hours: Yes

Contribution to Project:

Works under information management providing data entry services.

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 coordinator.

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

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

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 logistical and 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 part 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:

- 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, Pietermaritzburg)]. 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 (in 2008): Dr. Marjan Jongen of the Instituto Superior de Agronomia, Lisbon, Portugal; Matilde Alfaro-Barrios of Averaves-Investigaci?n y Conservaci?n, Uruguay. 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 Koppelaar, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, South Africa. In 2009-10: Nicole Hagenah, University of KwaZulu-Natal, South Africa.

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), 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 begins its twelfth year as an ecological 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.

To date, we have trained 73 local teachers, 37 who currently participate annually by bringing classes to Konza Prairie. Another 34 teachers are teaching students at regionally-distributed 'satellite' native prairie sites where long-term data are also being collected. Some of these teachers participate with their classes several years in a row and others return as their curriculum allows. Twelve of these teachers are from a nearby school district, which has 55% economically disadvantaged students. The administrators of this district have been enthusiastic supporters of our program. Other teachers are from rural Kansas districts with limited science resources and high immigrant populations. In 2009, 1232 students from 18 schools experienced 51 hands-on activities at Konza Prairie. The Prairies Across Kansas program impacted an additional 390 students across the state for a total of 1622 students (Table 1). Individual class data can be accessed along with the long-term databases through the Internet and manipulated in the classroom in ways that give students a better understanding of the process of science. To date we have reached > 9000 students from third grade through high school with SLTER activities at Konza Prairie and another 2100 across the state through PAK. In 2010, we anticipate involving ~1000 additional students in activities at Konza, with a similar number from around the state participating in PAK activities, substantially increasing the impact of our site-based SLTER program in Kansas.

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. This is the 15th year that a REU site program has been offered by the Division of Biology and Konza Prairie Biological Station, and in 2010 the site-based REU program supported 7 students, with another 9 students participating with support from individual grant supplements of University support (McNair Scholar's program and SUROP). For a list of current and recent REU student projects, see www.k-state.edu/bsanderc/reu/. 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.

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 Kansas, University of Colorado, 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.

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

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.

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.

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, Kansas State University. Manhattan, KS. 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.

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.

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 next visitor's day will be in September of 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 2008-10, this included visits by the Midwestern Science Coordinator for The Nature Conservancy, the Kansas Chapter of The Nature Conservancy, and meetings of the Kansas Cooperative Fish and Wildlife Service, The 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 conservation groups including the Tallgrass Legacy Alliance 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.

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 2008-2010. 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. This event is scheduled for October, 2010. The last Konza Prairie Visitor's Day was held September 27, 2008, and attracted approximately 1,200 people, with over 100 LTER scientists, students and docent volunteers assisting.

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,
- Bertrand, K.N., K.B. Gido, W.K. Dodds, J.N. Murdock, and M.R. Whiles., "Disturbance frequency and functional identity mediate ecosystem processes in prairie streams.", *Oikos*, p. 917, vol. 118, (2009). Published,
- 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,
- Casey, AE; Jones, KL; Sandercock, BK; Wisely, SM, "Heteroduplex molecules cause sexing errors in a standard molecular protocol for avian sexing", *MOLECULAR ECOLOGY RESOURCES*, p. 61, vol. 9, (2009). Published, 10.1111/j.1755-0998.2008.02307.
- Dragoo, JW; Coan, KE; Moore, KA; Henke, SE; Fleischer, RC; Wisely, SM, "Polymorphic microsatellite markers for the striped skunk, *Mephitis mephitis*, and other mephitids", *MOLECULAR ECOLOGY RESOURCES*, p. 383, vol. 9, (2009). Published, 10.1111/j.1755-0998.2008.02463.
- S.L. Johnson, S.K. Hamilton, N.B. Grimm, S.V. Gregory, C.N. Dahm, L.W. Cooper, L.R. Ashkenas, S.M. Thomas, R.W. Sheibley, J.D. Potter, B.R. Niederlehner, L.T. Johnson, A.M. Helton, C.M. Crenshaw, A.J. Burgin, M.J. Bernot, J.J. Beaulieu and C.P. Arango., "Nitrate removal in stream ecosystems measured by 15N addition experiments", *Limnology and Oceanography*, p. 653, vol. 54, (2009). Published,
- Harmon, ME; Silver, WL; Fasth, B; Chen, H; Burke, IC; Parton, WJ; Hart, SC; Currie, WS; LIDET, "Long-term patterns of mass loss during the decomposition of leaf and fine root litter: an intersite comparison", *GLOBAL CHANGE BIOLOGY*, p. 1320, vol. 15, (2009). Published, 10.1111/j.1365-2486.2008.01837.
- Margosian, ML; Garrett, KA; Hutchinson, JMS; With, KA, "Connectivity of the American Agricultural Landscape: Assessing the National Risk of Crop Pest and Disease Spread", *BIOSCIENCE*, p. 141, vol. 59, (2009). Published, 10.1525/bio.2009.59.2.
- McCulley, RL; Burke, IC; Lauenroth, WK, "Conservation of nitrogen increases with precipitation across a major grassland gradient in the Central Great Plains of North America", *OECOLOGIA*, p. 571, vol. 159, (2009). Published, 10.1007/s00442-008-1229-
- Morisette, J. T., A.D. Richardson, A.K. Knapp, J.I. Fisher , E.A. Graham, J. Abatzoglou, B.E. Wilson, D.D. Breshears, G.M. Henebry, J.M. Hanes and L. Liang., "Learning the rhythm of the seasons in the face of global change: phenological research in the 21st Century.", *Frontiers in Ecology and the Environment*, p. 253, vol. 7, (2009). Published,
- Dahm, S.V. Gregory, S.L. Johnson, J.L. Meyer, B.J. Peterson, G.C. Poole, H.M. Valett, J.R. Webster, C.P. Arango, J.J. Beaulieu, M.J. Bernot, A.J. Burgin, C.L. Crenshaw, A.M. Helton, L.T. Johnson, B.R. Niederlehner, J.D. Potter, R.W. Sheibley and S.M. Thom, "Nitrate removal in stream ecosystems measured by 15N addition.", *Limnology and Oceanography*, p. 666, vol. 54, (2009). Published,

- Nippert, J.B., P.A. Fay, J.D. Carlisle, A.K. Knapp and M.D. Smith., " Ecophysiological responses of two dominant grasses to altered temperature and precipitation regimes.", *Acta Oecologia*, p. 400, vol. 35, (2009). Published,
- Reed, HE; Blair, JM; Wall, DH; Seastedt, TR, "Impacts of management legacies on litter decomposition in response to reduced precipitation in a tallgrass prairie", *APPLIED SOIL ECOLOGY*, p. 79, vol. 42, (2009). Published, 10.1016/j.apsoil.2009.01.00
- Rivers, JW, "Parent-absent begging in the Brown-headed Cowbird (*Molothrus ater*): the role of short-term need and nestmate size", *BEHAVIORAL ECOLOGY AND SOCIOBIOLOGY*, p. 707, vol. 63, (2009). Published, 10.1007/s00265-008-0704-
- Wilgers, D.J. and E.A. Horne., "Differential responses to chemical stimuli in conspecific fecal pellets by an iguanid lizard *Crotaphytus collaris*.", *Journal of Ethology*, p. 157, vol. 27, (2009). Published,
- Williams, MA; Xia, K, "Characterization of the water soluble soil organic pool following the rewetting of dry soil in a drought-prone tallgrass prairie", *SOIL BIOLOGY & BIOCHEMISTRY*, p. 21, vol. 41, (2009). Published, 10.1016/j.soilbio.2008.08.01
- Wilson, GWT; Rice, CW; Rillig, MC; Springer, A; Hartnett, DC, "Soil aggregation and carbon sequestration are tightly correlated with the abundance of arbuscular mycorrhizal fungi: results from long-term field experiments", *ECOLOGY LETTERS*, p. 452, vol. 12, (2009). Published, 10.1111/j.1461-0248.2009.01303.
- Cheatham, M.R., M.N. Rouse, P.D. Esker, S. Ignacio, W. Pradel, R. Raymundo, A.H. Sparks, G.A. Forbes, T.R. Gordon and K.A. Garrett, "Beyond yield: Plant disease in the context of ecosystem services.", *Phytopathology*, p. 1228, vol. 99, (2009). Published,
- Heisler-White, J.L., J.M. Blair, E.F. Kelly, K. Harmony and A.K. Knapp, "Contingent productivity responses to more extreme rainfall regimes across a grassland biome.", *Global Change Biology*., p. 2894, vol. 15, (2009). Published,
- Worapong, J; Dendy, SP; Tang, Z; Awl, DJ; Garrett, KA, "Limiting temperatures for urediniospore germination are low in a systemic rust fungus of tallgrass prairie", *MYCOLOGIA*, p. 390, vol. 101, (2009). Published, 10.3852/08-10
- Middendorf, G., T.A. Becerra and D. Cline, "Transition and Resilience in the Kansas Flint Hills.", *Online Journal of Rural Research and Policy*., p. 1, vol. 4.3, (2009). Published,
- Presley, D.R., P.E. Hartley and M.D. Ransom, "Mineralogy and morphological properties of buried polygenetic paleosols formed in late quaternary sediments on upland landscapes of the central plains, USA.", *Geoderma*, p. 508, vol. 154, (2010). Published,
- Roth II, T.C. and V.V. Pravosudov, "Hippocampal volumes and neuron numbers increase along a gradient of environmental harshness: a large-scale comparison.", *Proceedings of the Royal Society B*., p. 401, vol. 276, (2009). Published,
- Smith, M.D., A.K. Knapp and S.L. Collins, " A framework for assessing ecosystem dynamics in response to chronic resource alterations induced by global change", *Ecology*, p. 3279, vol. 90, (2009). Published,
- Jumpponen, A. and Jones, K.L., "Massively parallel 454-sequencing of *Quercus macrocarpa* phyllosphere fungal communities indicates reduced richness and diversity in urban environments.", *New Phytologist*, p. 438, vol. 184, (2009). Published,
- Macpherson, GL, "CO₂ distribution in groundwater and the impact of groundwater extraction on the global C cycle", *CHEMICAL GEOLOGY*, p. 328, vol. 264, (2009). Published, 10.1016/j.chemgeo.2009.03.01
- Anderson, JF; Parrish, TD; Akhtar, M; Zurek, L; Hirt, H, "Antibiotic resistance of enterococci in American bison (*Bison bison*) from a nature preserve compared to that of enterococci in pastured cattle", *APPLIED AND ENVIRONMENTAL MICROBIOLOGY*, p. 1726, vol. 74, (2008). Published, 10.1128/AEM.02164-0
- Baer, SG; Blair, JM, "Grassland establishment under varying resource availability: A test of positive and negative feedback", *ECOLOGY*, p. 1859, vol. 89, (2008). Published,

- Behmer, ST; Joern, A, "Coexisting generalist herbivores occupy unique nutritional feeding niches", PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, p. 1977, vol. 105, (2008). Published, 10.1073/pnas.071187010
- Bengtson, JR; Evans-White, MA; Gido, KB, "Effects of grazing minnows and crayfish on stream ecosystem structure and function", JOURNAL OF THE NORTH AMERICAN BENTHOLOGICAL SOCIETY, p. 772, vol. 27, (2008). Published, 10.1899/07-136.
- Blundell, M.A., and B. Von Korff., "Bobolinks (*Dolichonyx oryzivorus*) nesting at Konza Prairie Biological Station, Riley County, Kansas.", Bulletin of the Kansas Ornithological Society, p. 21, vol. 59, (2008). Published,
- Brunsell, NA; Ham, JM; Owensby, CE, "Assessing the multi-resolution information content of remotely sensed variables and elevation for evapotranspiration in a tall-grass prairie environment", REMOTE SENSING OF ENVIRONMENT, p. 2977, vol. 112, (2008). Published, 10.1016/j.rse.2008.02.00
- Chalcraft, DR; Cox, SB; Clark, C; Cleland, EE; Suding, KN; Weiher, E; Pennington, D, "Scale-dependent responses of plant biodiversity to nitrogen enrichment", ECOLOGY, p. 2165, vol. 89, (2008). Published,
- 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., "Species responses to nitrogen fertilization in North American plant communities, and associated species traits.", Ecology, p. 1175, vol. 89, (2008). Published,
- Collins, SL; Suding, KN; Cleland, EE; Batty, M; Pennings, SC; Gross, KL; Grace, JB; Gough, L; Fargione, JE; Clark, CM, "RANK CLOCKS AND PLANT COMMUNITY DYNAMICS", ECOLOGY, p. 3534, vol. 89, (2008). Published,
- Dalgleish, HJ; Kula, AR; Hartnett, DC; Sandercock, BK, "Responses of two bunchgrasses to nitrogen addition in tallgrass prairie: the role of bud bank demography", AMERICAN JOURNAL OF BOTANY, p. 672, vol. 95, (2008). Published, 10.3732/ajb.200727
- Dodds, WK; Wilson, KC; Rehmeier, RL; Knight, GL; Wiggam, S; Falke, JA; Dalgleish, HJ; Bertrand, KN, "Comparing Ecosystem Goods and Services Provided by Restored and Native Lands", BIOSCIENCE, p. 837, vol. 58, (2008). Published, 10.1641/B58090
- Dodds, W.K. and R.M. Oakes., "Headwater influences on downstream water quality. Environmental Management", Environmental Management, p. 367, vol. 41, (2008). Published,
- Fay, PA; Kaufman, DM; Nippert, JB; Carlisle, JD; Harper, CW, "Changes in grassland ecosystem function due to extreme rainfall events: implications for responses to climate change", GLOBAL CHANGE BIOLOGY, p. 1600, vol. 14, (2008). Published, 10.1111/j.1365-2486.2008.01605.
- Gerten, D; Luo, Y; Le Maire, G; Parton, WJ; Keough, C; Weng, E; Beier, C; Ciais, P; Cramer, W; Dukes, JS; Hanson, PJ; Knapp, AAK; Linder, S; Nepstad, D; Rustad, L; Sowerby, A, "Modelled effects of precipitation on ecosystem carbon and water dynamics in different climatic zones", GLOBAL CHANGE BIOLOGY, p. 2365, vol. 14, (2008). Published, 10.1111/j.1365-2486.2008.01651.
- Han, XM; Dendy, SP; Garrett, KA; Fang, L; Smith, MD, "Comparison of damage to native and exotic tallgrass prairie plants by natural enemies", PLANT ECOLOGY, p. 197, vol. 198, (2008). Published, 10.1007/s11258-008-9395-
- Heisler, JL; Knapp, AK, "Temporal coherence of aboveground net primary productivity in mesic grasslands", ECOGRAPHY, p. 408, vol. 31, (2008). Published, 10.1111/j.2008.0906-7590.05351.
- Heisler-White, JL; Knapp, AK; Kelly, EF, "Increasing precipitation event size increases aboveground net primary productivity in a semi-arid grassland", OECOLOGIA, p. 129, vol. 158, (2008). Published, 10.1007/s00442-008-1116-
- Heneghan, L; Miller, SP; Baer, S; Callahan, MA; Montgomery, J; Pavao-Zuckerman, M; Rhoades, CC; Richardson, S, "Integrating Soil Ecological Knowledge into Restoration Management", RESTORATION ECOLOGY, p. 608, vol. 16, (2008). Published, 10.1111/j.1526-100X.2008.00477.

- Hutchinson, S.L., J.K. Koelliker and A.K. Knapp., "Development of water usage coefficients for the fully-watered tallgrass prairie.", *Transactions of the American Society of Agricultural Engineers*, p. 153, vol. 51, (2008). Published,
- Johnson, NC; Rowland, DL; Corkidi, L; Allen, EB, "PLANT WINNERS AND LOSERS DURING GRASSLAND N-EUTROPHICATION DIFFER IN BIOMASS ALLOCATION AND MYCORRHIZAS", *ECOLOGY*, p. 2868, vol. 89, (2008). Published,
- Jonas, JL; Joern, A, "Host-plant quality alters grass/forb consumption by a mixed-feeding insect herbivore, *Melanoplus bivittatus* (Orthoptera : Acrididae)", *ECOLOGICAL ENTOMOLOGY*, p. 546, vol. 33, (2008). Published, 10.1111/j.1365-2311.2008.01004.
- Knapp, AK; Beier, C; Briske, DD; Classen, AT; Luo, Y; Reichstein, M; Smith, MD; Smith, SD; Bell, JE; Fay, PA; Heisler, JL; Leavitt, SW; Sherry, R; Smith, B; Weng, E, "Consequences of More Extreme Precipitation Regimes for Terrestrial Ecosystems", *BIOSCIENCE*, p. 811, vol. 58, (2008). Published, 10.1641/B58090
- Knapp, AK; Briggs, JM; Collins, SL; Archer, SR; Bret-Harte, MS; Ewers, BE; Peters, DP; Young, DR; Shaver, GR; Pendall, E; Cleary, MB, "Shrub encroachment in North American grasslands: shifts in growth form dominance rapidly alters control of ecosystem carbon inputs", *GLOBAL CHANGE BIOLOGY*, p. 615, vol. 14, (2008). Published, 10.1111/j.1365-2486.2007.01512.
- Kosciuch, KL; Sandercock, BK, "Cowbird removals unexpectedly increase productivity of a brood parasite and the songbird host", *ECOLOGICAL APPLICATIONS*, p. 537, vol. 18, (2008). Published,
- Kosciuch, KL; Rivers, JW; Sandercock, BK, "Stable isotopes identify the natal origins of a generalist brood parasite, the brown-headed cowbird *Molothrus ater*", *JOURNAL OF AVIAN BIOLOGY*, p. 364, vol. 39, (2008). Published, 10.1111/j.2008.0908-8857.04170.
- Loaiza, V., J.L. Jonas and A. Joern., "Does dietary-P affect feeding and performance in the mixed-feeding grasshopper (Acrididae) *Melanoplus bivittatus*?", *Environmental Entomology*, p. 333, vol. 37, (2008). Published,
- Luo, YQ; Gerten, D; Le Maire, G; Parton, WJ; Weng, ES; Zhou, XH; Keough, C; Beier, C; Ciais, P; Cramer, W; Dukes, JS; Emmett, B; Hanson, PJ; Knapp, A; Linder, S; Nepstad, D; Rustad, L, "Modeled interactive effects of precipitation, temperature, and [CO₂] on ecosystem carbon and water dynamics in different climatic zones", *GLOBAL CHANGE BIOLOGY*, p. 1986, vol. 14, (2008). Published, 10.1111/j.1365-2486.2008.01629.
- Macpherson, GL; Roberts, JA; Blair, JM; Townsend, MA; Fowle, DA; Beisner, KR, "Increasing shallow groundwater CO₂ and limestone weathering, Konza Prairie, USA", *GEOCHIMICA ET COSMOCHIMICA ACTA*, p. 5581, vol. 72, (2008). Published, 10.1016/j.gca.2008.09.00
- Mandyam, K; Jumpponen, A, "Seasonal and temporal dynamics of arbuscular mycorrhizal and dark septate endophytic fungi in a tallgrass prairie ecosystem are minimally affected by nitrogen enrichment", *MYCORRHIZA*, p. 145, vol. 18, (2008). Published, 10.1007/s00572-008-0165-
- Marshall, JD; Blair, JM; Peters, DPC; Okin, G; Rango, A; Williams, M, "Predicting and understanding ecosystem responses to climate change at continental scales", *FRONTIERS IN ECOLOGY AND THE ENVIRONMENT*, p. 273, vol. 6, (2008). Published, 10.1890/07016
- Matlack, RS; Kaufman, DW; Kaufman, GA, "Influence of woody vegetation on small mammals in tallgrass prairie", *AMERICAN MIDLAND NATURALIST*, p. 7, vol. 160, (2008). Published,
- McKinley, DC; Blair, JM, "Woody plant encroachment by *Juniperus virginiana* in a mesic native grassland promotes rapid carbon and nitrogen accrual", *ECOSYSTEMS*, p. 454, vol. 11, (2008). Published, 10.1007/s10021-008-9133-
- McKinley, DC; Rice, CW; Blair, JM, "Conversion of grassland to coniferous woodland has limited effects on soil nitrogen cycle processes", *SOIL BIOLOGY & BIOCHEMISTRY*, p. 2627, vol. 40, (2008). Published, 10.1016/j.soilbio.2008.07.00
- Mulholland, PJ; Helton, AM; Poole, GC; Hall, RO; Hamilton, SK; Peterson, BJ; Tank, JL; Ashkenas, LR; Cooper, LW; Dahm, CN; Dodds, WK; Findlay, SEG; Gregory, SV; Grimm, NB; Johnson, SL; McDowell, WH; Meyer, JL; Valett, HM; Webster, JR; Arango, CP; Beaulieu,

- "Stream denitrification across biomes and its response to anthropogenic nitrate loading", *NATURE*, p. 202, vol. 452, (2008). Published, 10.1038/nature0668
- Noeker, JK; Sandercock, BK, "Phenotypic correlates and survival consequences of male mating success in lek-mating greater prairie-chickens (*Tympanuchus cupido*)", *BEHAVIORAL ECOLOGY AND SOCIOBIOLOGY*, p. 1377, vol. 62, (2008). Published, 10.1007/s00265-008-0566-
- O'Brien, JM; Dodds, WK, "Ammonium uptake and mineralization in prairie streams: chamber incubation and short-term nutrient addition experiments", *FRESHWATER BIOLOGY*, p. 102, vol. 53, (2008). Published, 10.1111/j.1365-2427.2007.01870.
- Powell, AFLA, "Responses of breeding birds in tallgrass prairie to fire and cattle grazing", *JOURNAL OF FIELD ORNITHOLOGY*, p. 41, vol. 79, (2008). Published, 10.1111/j.1557-9263.2008.00144.
- Sandercock, B.K., A.E. Casey, D.E. Green, H.S. Ip, and K.A. Converse., "Reovirus associated with mortality of an Upland Sandpiper.", *Wader Study Group Bulletin*, p. 60, vol. 115, (2008). Published,
- Sandercock, BK; Hewett, EL; Kosciuch, KL, "EFFECTS OF EXPERIMENTAL COWBIRD REMOVALS ON BROOD PARASITISM AND NEST PREDATION IN A GRASSLAND SONGBIRD", *AUK*, p. 820, vol. 125, (2008). Published, 10.1525/auk.2008.0615
- Sandercock, BK; Jensen, WE; Williams, CK; Applegate, RD, "Demographic sensitivity of population change in northern bobwhite", *JOURNAL OF WILDLIFE MANAGEMENT*, p. 970, vol. 72, (2008). Published, 10.3193/2007-12
- Schook, DM; Collins, MD; Jensen, WE; Williams, PJ; Bader, NE; Parker, TH, "GEOGRAPHIC PATTERNS OF SONG SIMILARITY IN THE DICKCISSEL (*SPIZA AMERICANA*)", *AUK*, p. 953, vol. 125, (2008). Published, 10.1525/auk.2009.0716
- Stagliano, DM; Whiles, MR, "Life history and production of the riffle beetle, *Stenelmis crenata* (Say, 1824) (Coleoptera : Elmidae), in a tallgrass prairie stream", *AQUATIC INSECTS*, p. 197, vol. 30, (2008). Published, 10.1080/0165042080233114
- Strum, K.M., M. Alfaro, B. Haase, M.J. Hooper, K.A. Johnson, R.B. Lanctot, A.J. Lesterhuis, L. Lopez, A.C. Matz, C. Morales, B. Paulson, B.K. Sandercock, J. Torres-Dowdall and M.E. Zaccagnini., "Plasma cholinesterases for monitoring pesticide exposure in Nearctic-Neotropical migratory shorebirds.", *Ornithology*, p. 641, vol. 19 (Sup), (2008). Published,
- Swemmer, AM; Knapp, AK, "DEFOLIATION SYNCHRONIZES ABOVEGROUND GROWTH OF CO-OCCURRING C-4 GRASS SPECIES", *ECOLOGY*, p. 2860, vol. 89, (2008). Published,
- Towne, G.E. and K.E. Kemp., "Long-term response patterns of tallgrass prairie to frequent summer burning.", *Rangeland Ecology and Management*, p. 509, vol. 61, (2008). Published,
- Veen, GF; Blair, JM; Smith, MD; Collins, SL, "Influence of grazing and fire frequency on small-scale plant community structure and resource variability in native tallgrass prairie", *OIKOS*, p. 859, vol. 117, (2008). Published, 10.1111/j.2008.0030-1299.16515.
- Williamson, CE; Dodds, W; Kratz, TK; Palmer, MA, "Lakes and streams as sentinels of environmental change in terrestrial and atmospheric processes", *FRONTIERS IN ECOLOGY AND THE ENVIRONMENT*, p. 247, vol. 6, (2008). Published, 10.1890/07014
- Wilson, GWT; Williamson, MW, "Topsin-M: the new benomyl for mycorrhizal-suppression experiments", *MYCOLOGIA*, p. 548, vol. 100, (2008). Published, 10.3872/08-024
- Buis, GM; Blair, JM; Burkepile, DE; Burns, CE; Chamberlain, AJ; Chapman, PL; Collins, SL; Fynn, RWS; Govender, N; Kirkman, KP; Smith, MD; Knapp, AK, "Controls of Aboveground Net Primary Production in Mesic Savanna Grasslands: An Inter-Hemispheric Comparison", *ECOSYSTEMS*, p. 982, vol. 12, (2009). Published, 10.1007/s10021-009-9273-
- Craine, J; Spurr, R; McLauchlan, K; Fierer, N, "Landscape-level variation in temperature sensitivity of soil organic carbon decomposition", *SOIL BIOLOGY & BIOCHEMISTRY*, p. 373, vol. 42, (2010). Published, 10.1016/j.soilbio.2009.10.02

- Dalgleish, HJ; Hartnett, DC, "The effects of fire frequency and grazing on tallgrass prairie productivity and plant composition are mediated through bud bank demography", *PLANT ECOLOGY*, p. 411, vol. 201, (2009). Published, 10.1007/s11258-008-9562-
- Hall, RO; Tank, JL; Sobota, DJ; Mulholland, PJ; O'Brien, JM; Dodds, WK; Webster, JR; Valett, HM; Poole, GC; Peterson, BJ; Meyer, JL; McDowell, WH; Johnson, SL; Hamilton, SK; Grimm, NB; Gregory, SV; Dahm, CN; Cooper, LW; Ashkenas, LR; Thomas, SM; Sheibley,, "Nitrate removal in stream ecosystems measured by N-15 addition experiments: Total uptake", *LIMNOLOGY AND OCEANOGRAPHY*, p. 653, vol. 54, (2009). Published,
- Kitchen, DJ; Blair, JM; Callahan, MA, "Annual fire and mowing alter biomass, depth distribution, and C and N content of roots and soil in tallgrass prairie", *PLANT AND SOIL*, p. 235, vol. 323, (2009). Published, 10.1007/s11104-009-9931-
- Mulholland, PJ; Hall, RO; Sobota, DJ; Dodds, WK; Findlay, SEG; Grimm, NB; Hamilton, SK; McDowell, WH; O'Brien, JM; Tank, JL; Ashkenas, LR; Cooper, LW; Dahm, CN; Gregory, SV; Johnson, SL; Meyer, JL; Peterson, BJ; Poole, GC; Valett, HM; Webster, JR; Arango,, "Nitrate removal in stream ecosystems measured by N-15 addition experiments: Denitrification", *LIMNOLOGY AND OCEANOGRAPHY*, p. 666, vol. 54, (2009). Published,
- Reed, HE; Blair, JM; Wall, DH; Seastedt, TR, "Impacts of management legacies on litter decomposition in response to reduced precipitation in a tallgrass prairie", *APPLIED SOIL ECOLOGY*, p. 79, vol. 42, (2009). Published,
- Woods, TM; Hartnett, DC; Ferguson, CJ, "High propagule production and reproductive fitness homeostasis contribute to the invasiveness of *Lespedeza cuneata* (Fabaceae)", *BIOLOGICAL INVASIONS*, p. 1913, vol. 11, (2009). Published, 10.1007/s10530-008-9369-
- Bremer, DJ; Ham, JM, "Net Carbon Fluxes Over Burned and Unburned Native Tallgrass Prairie", *RANGELAND ECOLOGY & MANAGEMENT*, p. 72, vol. 63, (2010). Published, 10.2111/.1/REM-D-09-00010.
- Jangid, K; Williams, MA; Franzluebbers, AJ; Blair, JM; Coleman, DC; Whitman, WB, "Development of soil microbial communities during tallgrass prairie restoration", *SOIL BIOLOGY & BIOCHEMISTRY*, p. 302, vol. 42, (2010). Published, 10.1016/j.soilbio.2009.11.00
- Johnson, NC; Wilson, GWT; Bowker, MA; Wilson, JA; Miller, RM, "Resource limitation is a driver of local adaptation in mycorrhizal symbioses", *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*, p. 2093, vol. 107, (2010). Published, 10.1073/pnas.090671010
- Jumpponen, A; Jones, KL, "Seasonally dynamic fungal communities in the *Quercus macrocarpa* phyllosphere differ between urban and nonurban environments", *NEW PHYTOLOGIST*, p. 496, vol. 186, (2010). Published, 10.1111/j.1469-8137.2010.03197.
- Jumpponen, A; Jones, KL; Mattox, D; Yaeger, C, "Massively parallel 454-sequencing of fungal communities in *Quercus* spp. ectomycorrhizas indicates seasonal dynamics in urban and rural sites", *MOLECULAR ECOLOGY*, p. 41, vol. 19, (2010). Published, 10.1111/j.1365-294X.2009.04483.
- Klug, PE; Jackrel, SL; With, KA, "Linking snake habitat use to nest predation risk in grassland birds: the dangers of shrub cover", *OECOLOGIA*, p. 803, vol. 162, (2010). Published, 10.1007/s00442-009-1549-
- Melzer, SE; Knapp, AK; Kirkman, KP; Smith, MD; Blair, JM; Kelly, EF, "Fire and grazing impacts on silica production and storage in grass dominated ecosystems", *BIOGEOCHEMISTRY*, p. 263, vol. 97, (2010). Published, 10.1007/s10533-009-9371-
- Murdock, JN; Gido, KB; Dodds, WK; Bertrand, KN; Whiles, MR, "Consumer return chronology alters recovery trajectory of stream ecosystem structure and function following drought", *ECOLOGY*, p. 1048, vol. 91, (2010). Published,
- O'Brien, JM; Dodds, WK, "Saturation of NO₃- uptake in prairie streams as a function of acute and chronic N exposure", *JOURNAL OF THE NORTH AMERICAN BENTHOLOGICAL SOCIETY*, p. 627, vol. 29, (2010). Published, 10.1899/09-021.
- Rivers, JW; Gipson, PS; Althoff, DP; Pontius, JS, "Long-Term Community Dynamics of Small Landbirds with and Without Exposure to Extensive Disturbance from Military Training Activities", *ENVIRONMENTAL MANAGEMENT*, p. 203, vol. 45, (2010). Published, 10.1007/s00267-009-9421-

- Rivers, JW; Jensen, WE; Kosciuch, KL; Rothstein, SI, "COMMUNITY-LEVEL PATTERNS OF HOST USE BY THE BROWN-HEADED COWBIRD (MOLOTHRUS ATER), A GENERALIST BROOD PARASITE", *AUK*, p. 263, vol. 127, (2010). Published, 10.1525/auk.2009.0905
- Saleh, AA; Ahmed, HU; Todd, TC; Travers, SE; Zeller, KA; Leslie, JF; Garrett, KA, "Relatedness of *Macrophomina phaseolina* isolates from tallgrass prairie, maize, soybean and sorghum", *MOLECULAR ECOLOGY*, p. 79, vol. 19, (2010). Published, 10.1111/j.1365-294X.2009.04433.
- Spasojevic, MJ; Aicher, RJ; Koch, GR; Marquardt, ES; Mirotchnick, N; Troxler, TG; Collins, SL, "Fire and grazing in a mesic tallgrass prairie: impacts on plant species and functional traits", *ECOLOGY*, p. 1651, vol. 91, (2010). Published,
- Taylor, EB; Williams, MA, "Microbial Protein in Soil: Influence of Extraction Method and C Amendment on Extraction and Recovery", *MICROBIAL ECOLOGY*, p. 390, vol. 59, (2010). Published, 10.1007/s00248-009-9593-
- Travers, SE; Tang, ZW; Caragea, D; Garrett, KA; Hulbert, SH; Leach, JE; Bai, JF; Saleh, A; Knapp, AK; Fay, PA; Nippert, J; Schnable, PS; Smith, MD, "Variation in gene expression of *Andropogon gerardii* in response to altered environmental conditions associated with climate change", *JOURNAL OF ECOLOGY*, p. 374, vol. 98, (2010). Published, 10.1111/j.1365-2745.2009.01618.
- Woods, TM; Hartnett, DC; Ferguson, CJ, "High propagule production and reproductive fitness homeostasis contribute to the invasiveness of *Lespedeza cuneata* (Fabaceae)", *BIOLOGICAL INVASIONS*, p. 1913, vol. 11 (8), (2009). Published,
- Craine, J.M. and R.D. Jackson, "Nitrogen and phosphorus limitation in soils from 98 North American grasslands", *PLANT AND SOIL*, p. , vol. , (2010). Accepted,
- Spasojevic, MJ; Aicher, RJ; Koch, GR; Marquardt, ES; Mirotchnick, N; Troxler, TG and SL Collins, "Fire and grazing in a mesic tallgrass prairie: impacts on plant species and functional traits", *Ecology*, p. 1651, vol. 91, (2010). Published,
- Augustine, J.K., J.J. Millsbaugh, and B.K. Sandercock, "Testosterone: a proximate factor mediating mating success in male Greater Prairie-Chickens?", *Studies in Avian Biology*, p. , vol. , (2010). Accepted,
- Gregory, A.J., L.B. McNew, T.J. Prebyl, B.K. Sandercock, and S.M. Wisely, "A multiscale hierarchical modeling approach to mapping lekking habitats of Greater Prairie-Chickens in eastern Kansas", *STUDIES IN AVIAN BIOLOGY*, p. , vol. , (2010). Accepted,
- McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock, "Reproductive chronology of Greater Prairie-Chickens in Kansas", *STUDIES IN AVIAN BIOLOGY*, p. , vol. , (2010). Accepted,
- McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock, "Evidence of human-mediated life-history evolution in Greater Prairie-Chickens", *STUDIES IN AVIAN BIOLOGY*, p. , vol. , (2010). Accepted,
- Ippolito, JA; Blecker, SW; Freeman, CL; McCulley, RL; Blair, JM; Kelly, EF, "Phosphorus biogeochemistry across a precipitation gradient in grasslands of central North America", *JOURNAL OF ARID ENVIRONMENTS*, p. 954, vol. 74, (2010). Published, 10.1016/j.jaridenv.2010.01.00
- Jumpponen, A., K.L. Jones, and J.M. Blair, "Vertical distribution of fungal communities in tallgrass prairie soil", *MYCOLOGIA*, p. , vol. , (2010). Accepted,
- Craine, J.M., A.J. Elmore, K.C. Olson, and D. Tolleson, "Climate change and nutritional stress in cattle", *GLOBAL CHANGE BIOLOGY*, p. , vol. , (2010). Accepted,
- McLauchlan, K.K., C.J. Ferguson, I.E. Wilson, T.W. Ocheltree, and J. M. Craine, "Declining nitrogen availability over thirteen decades in central North American grasslands", *NEW PHYTOLOGIST*, p. , vol. , (2010). Accepted,
- Lambert, A.M., S.G. Baer, and D.J. Gibson, "Intraspecific variation in ecophysiology of three dominant prairie grasses used in restoration: cultivar vs. non-cultivar population sources", *RESTORATION ECOLOGY*, p. , vol. , (2010). Accepted,

- Klopf, R.P. and S.G. Baer, "Root dynamics of cultivar and non-cultivar population sources of three dominant grasses during initial establishment of tallgrass prairie", *RESTORATION ECOLOGY*, p. , vol. , (2010). Accepted,
- Mandyam, K., T. Loughlin, and A. Jumpponen, "Isolation and morphological and metabolic characterization of common endophytes in annually burned tallgrass prairie", *MYCOLOGIA*, p. 813, vol. 102, (2010). Published,
- Bouska, WW; Paukert, CP, "Road Crossing Designs and Their Impact on Fish Assemblages of Great Plains Streams", *TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY*, p. 214, vol. 139, (2010). Published, 10.1577/T09-040.
- Jumpponen, A., K. Keating, G.L.Gadbury, K.L. Jones, and J.D. Mattox, "Multi-element fingerprinting and high throughput sequencing identify multiple elements that affect fungal communities in *Quercus macrocarpa* foliage", *PLANT SIGNALING AND BEHAVIOR*, p. , vol. , (2010). Accepted,
- Banner, EBK; Stahl, AJ; Dodds, WK, "Stream Discharge and Riparian Land Use Influence In-Stream Concentrations and Loads of Phosphorus from Central Plains Watersheds", *ENVIRONMENTAL MANAGEMENT*, p. 552, vol. 44, (2009). Published, 10.1007/s00267-009-9332-
- Knapp, CW; Dodds, WK; Wilson, KC; O'Brien, JM; Graham, DW, "Spatial Heterogeneity of Denitrification Genes in a Highly Homogenous Urban Stream", *ENVIRONMENTAL SCIENCE & TECHNOLOGY*, p. 4273, vol. 43, (2009). Published, 10.1021/es900140
- Wilson, KC; Dodds, WK, "Centimeter-scale stream substratum heterogeneity and metabolic rates", *HYDROBIOLOGIA*, p. 53, vol. 623, (2009). Published, 10.1007/s10750-008-9647-
- Johnson, LT; Tank, JL; Dodds, WK, "The influence of land use on stream biofilm nutrient limitation across eight North American ecoregions", *CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES*, p. 1081, vol. 66, (2009). Published, 10.1139/F09-06
- Evans-White, MA; Dodds, WK; Huggins, DG; Baker, DS, "Thresholds in macroinvertebrate biodiversity and stoichiometry across water-quality gradients in Central Plains (USA) streams", *JOURNAL OF THE NORTH AMERICAN BENTHOLOGICAL SOCIETY*, p. 855, vol. 28, (2009). Published, 10.1899/08-113.
- Dodds, W.K., W.H. Clements, K.B. Gido, R.H. Hilderbrand, and R.S. King, "Thresholds, breakpoints, and nonlinearity in freshwaters as related to management", *JOURNAL OF THE NORTH AMERICAN BENTHOLOGICAL SOCIETY*, p. 988, vol. 29, (2010). Published,
- Gido, K.B., W.K. Dodds, and M. Eberle, "Retrospective analysis of fish community change during a half-century of landuse and streamflow changes", *JOURNAL OF THE NORTH AMERICAN BENTHOLOGICAL SOCIETY*, p. , vol. , (2010). Accepted,
- Craine, J.M., E.G. Towne, and J.B. Nippert, "Climate controls on grass culm production over a quarter century in a tallgrass prairie", *ECOLOGY*, p. 2132, vol. 91, (2010). Published,
- McCain, K.N.S., S.G. Baer, J.M. Blair, and G.W.T. Wilson, "Dominant grasses suppress local diversity in restored tallgrass prairie", *RESTORATION ECOLOGY*, p. , vol. , (2010). Accepted,
- Strum, K.M., M.J. Hooper, K.A. Johnson, R.B. Lanctot, M.E. Zaccagnini, and B.K. Sandercock, "Exposure of migratory nonbreeding shorebirds to cholinesterase-inhibiting contaminants in the Western Hemisphere", *THE CONDOR*, p. 15, vol. 112, (2010). Published,
- Molecular Ecology Resources Primer Development Consortium et al, "Permanent Genetic Resources added to Molecular Ecology Resources Database 1 May 2009 31 July 2009", *MOLECULAR ECOLOGY RESOURCES*, p. 1460, vol. 9, (2010). Published,
- Grace, T., A. Joern, S.J. Brown, J.L. Apple, and S.M. Wisely, "Highly polymorphic microsatellites in the North American Range Land Grasshopper *Hesperotettix viridis*", *JOURNAL OF ORTHOPTERA RESEARCH*, p. 19, vol. 18, (2009). Published,
- Johnson, N.C., V.B. Chaudhary, J.D. Hoeksema, J.M. Moore, A. Pringle, J.A. Umbanhowar, and G.W.T. Wilson, "Mysterious mycorrhizae? A field trip and classroom experiment to demystify the symbioses formed between plants and fungi", *AMERICAN BIOLOGY TEACHER*, p. 434, vol. 71, (2009). Published,

- Kaufman, D.W. and G.A. Kaufman, "The woodland vole on Konza Prairie Biological Station, Kansas", *TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE*, p. 229, vol. 112, (2009). Published,
- McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock, "Estimating the stage of incubation for nests of Greater Prairie-chickens using egg flotation: a float curve for grouse", *GROUSE NEWS*, p. 12, vol. 38, (2009). Published,
- Johnson, NC; Wilson, GWT; Bowker, MA; Wilson, JA; Miller, RM, "Resource limitation is a driver of local adaptation in mycorrhizal symbioses", *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*, p. 2093, vol. 107, (2010). Published,
- Roth, T.C., L.D. LaDage, and V.V. Pravosudov, "Learning capabilities enhanced in harsh environments: a common garden approach", *PROCEEDINGS OF THE ROYAL SOCIETY BIOLOGICAL SCIENCES*, p. 1, vol. , (2010). Published,
- Apple J., T. Grace, A. Joern, P. St. Amand, and S.M. Wisely, "Comparative genome scan detects host-related divergent selection in the grasshopper *Hesperotettix viridis*", *MOLECULAR ECOLOGY*, p. , vol. , (2010). Accepted,
- Grace, T., F. Dowell, A. Joern, S.M. Wisely, S.J. Brown, and E. Maghirang, "Divergent host plant adaptation drives the evolution of reproductive isolation in the grasshopper *Hesperotettix viridis* (Orthoptera: Acrididae)", *Biological Journal of the Linnean Society*, p. , vol. , (2010). Accepted,
- Loaiza, V., J.L. Jonas, and A. Joern, "Local distributions of grasshoppers (Orthoptera: Acrididae) respond to foliar nitrogen but not phosphorus in native grassland", *Insect Science*, p. , vol. , (2010). Accepted,
- Casey, A.E., B.K. Sandercock, and S.M. Wisely, "Genetic parentage and local population structure in the socially monogamous Upland Sandpiper", *Condor*, p. , vol. , (2010). Accepted,
- Kaufman, G.A. and D.W. Kaufman, "The meadow jumping mouse on Konza Prairie Biological Station, Kansas", *TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE*, p. , vol. , (2010). Accepted,
- Kaufman, D.W., G.A. Kaufman, and D.E. Brillhart, "Small mammals as winter prey of long-eared owls in Kansas", *TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE*, p. , vol. , (2010). Accepted,
- Kaufman, G.A., D.M. Kaufman, and D.W. Kaufman, ""Treated" versus "new" traps--does chronic applications of disinfectant to live traps reduce rodent trappability?", *Southwestern Naturalist*, p. , vol. , (2010). Accepted,
- Hartnett, D.C., "Into Africa: Promoting international ecological research and training in the developing world", *BULLETIN OF THE ECOLOGICAL SOCIETY OF AMERICA*, p. 202, vol. 91, (2010). Published,
- Craine, J.M. and E.G. Towne, "High leaf tissue density grassland species consistently more abundant across topographic and disturbance contrasts in a North American tallgrass prairie", *PLANT AND SOIL*, p. , vol. , (2010). Accepted,
- Bernot, M.J., D.J. Sobota, R.O. Hall Jr., P.J. Mulholland, W. K. Dodds, J.R. Webster, J.L. Tank, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, S.V. Gregory, N.B. Grimm, S.K. Hamilton, S.L. Johnson, W.H. McDowell, J.L. Meyer, B. Peterson, G.C. Poole, H.M. Valett., "Inter-regional comparison of land-use effects on stream metabolism", *FRESHWATER BIOLOGY*, p. 1874, vol. 55, (2010). Published, 10.1111/j.1365-2427.2010.02422.x

Books or Other One-time Publications

- G.L. Gadbury, K.A. Garrett and D.B. Allison, "Challenges and approaches to statistical design and inference in high dimensional investigations.", (). Book, Accepted
Editor(s): D.A. Belostotsky

Collection: Plant Systems Biology, Methods in Molecular Biology Series.

Bibliography: The Humana Press Inc.. Totowa, NJ.

K.A. Garrett, M. Nita, E.D. De Wolf, L. Gomez and A.H. Sparks, "Plant pathogens as indicators of climate change .", (2009). Book, Published

Editor(s): T. Letcher

Collection: Climate and Global Change: Observed Impacts on Planet Earth.

Bibliography: Elsevier

Peters D.P.C., B.T. Bestelmeyer, A.K. Knapp, J.E. Herrick, H.C. Monger and K.M. Havstad, "Approaches to predicting broad-scale regime shifts using changing pattern-process relationships across scales.", (). Book, Accepted

Editor(s): S. Miao, S. Carstenn and M. Nungesser

Collection: Real World Ecology: Design and Analyses of Large-Scale and Long-Term Research.

Bibliography: Springer-Verlag, NY.

Gibson, D.J., " Grasses and Grassland Ecology.", (2009). Book, Published

Bibliography: 320 pages.

Oxford University Press, Oxford, UK.

Grace, T., "Host associated genetic divergence and sexual isolation in the grasshopper *Hesperotettix viridis* (Orthoptera: Acrididae)", (2009).

Thesis, Published

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

Macpherson, G. L., "Groundwater CO₂: Is it responding to atmospheric CO₂?", (2009). conference proceeding, Published

Collection: Proceedings of the 24th IAGS

Bibliography: Fredericton, New Brunswick, Canada, June 1-4, v. II, p. 995-998.

An, N., "Estimating annual net primary productivity of the tallgrass prairie ecosystem of the Central Great Plains using AVHRR NDVI",

(2009). Thesis, Published

Bibliography: MS Thesis, University of Kansas, Lawrence, Kansas

Casey, A.E., "Fine-scale genetic structure and extra-pair parentage in the socially monogamous Upland Sandpiper.", (2008). Thesis, Published

Bibliography: M.S. thesis, Kansas State University. Manhattan, KS. 56 pp

Coolon, J., "Ecological genomics of nematode responses to different bacterial environments.", (2008). Thesis, Published

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

Heisler, J. L., "Sensitivity of grassland ecosystems across the Great Plains to present and future variability.", (2008). Thesis, Published

Bibliography: PhD Dissertation, Colorado State University. Fort Collins, CO. 161 pp

Hoover, D., "Altered rainfall due to climate change: Modeling the ecological effects on grasslands .", (2008). Thesis, Published

Bibliography: MS Thesis, University of Connecticut. Storrs,CT. 63 pp

Mandyam, K.G., "Dark spetate fungal endophytes from a tallgrass prairie and their continuum of interactions with host plants.", (2008). Thesis, Published

Bibliography: PhD Dissertation, Kansas State University. Manhattan, KS. 136 pp

Nepal, M.P., "Systematics and reproductive biology of *Morus L.* (Moraceae).", (2008). Thesis, Published

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

Schmitt McCain, K.N., "Limitations to plant diversity and productivity in tallgrass prairie.", (2008). Thesis, Published

Bibliography: PhD Dissertation, Kansas State University. Manhattan, KS. 137 pp

Strum, K.M., "Exposure of migratory shorebirds to organophosphorus and carbamate pesticides at migratory stopover and non-breeding sites in the western hemisphere.", (2008). Thesis, Published

Bibliography: M.S. thesis , Kansas State University. Manhattan, KS. 76 pp

- Garrett, K. A., "Climate change and plant disease risk.", (2008). Book, Published
Collection: Global Climate Change and Extreme Weather Events: Understanding the Contributions to Infectious Disease Emergence.
Bibliography: Page 143-155. National Academies Press.
- Garrett, K.A., and C.M. Cox, "Applied biodiversity science: Managing emerging diseases in agriculture and linked natural systems.", (2008). Book, Published
Editor(s): R. Ostfeld, F. Keesing, V. Eviner
Collection: Infectious Disease Ecology: Effects of Ecosystems on Disease and of Disease on Ecosystems.
Bibliography: Page 368-386. Princeton University Press.
- Kageyama, S.A., K.G. Mandyam, and A. Jumpponen, "Diversity, function and potential applications of the root-associated endophytes.", (2008). Book, Published
Editor(s): Varma, A.
Collection: Mycorrhiza: Genetics and Molecular Biology, Eco-Function, Biotechnology, Eco-Physiology, Structure and Systematics.
Bibliography: Page 29-59. Springer-Verlag, Berlin.
- Knapp A.K., J.K. McCarron, A.M. Silletti, G.A. Hoch, J.L. Heisler, M.S. Lett, J.M. Blair, J.M. Briggs and M.D. Smith., "Ecological consequences of the replacement of native grassland by *Juniperus virginiana* and other woody plants.", (2008). Book, Submitted
Editor(s): O.W. Van Auken
Collection: Ecological Studies Vol. 196, Western North American *Juniperus* communities: A dynamic vegetation type.
Bibliography: Page 156-169. Springer-Verlag, NY.
- McKinley, D.C., M.D. Norris, L.C. Johnson and J.M. Blair., "Biogeochemical changes associated with *Juniperus virginiana* encroachment into grasslands.", (2008). Book, Published
Editor(s): O.W. Van Auken
Collection: Ecological Studies Vol. 196, Western North American *Juniperus* communities: A dynamic vegetation type.
Bibliography: Page 170-187. Springer-Verlag, NY.
- Middendorf, G., D. Cline, and L. Bloomquist, "Agrarian Landscape Transition in the Flint Hills of Kansas: Legacies and Resilience.", (2008). Book, Published
Editor(s): Charles Redman and David Foster
Collection: Agrarian Landscapes in Transition: Comparisons of Long Term Ecological & Cultural Change.
Bibliography: Page 206-237. Oxford University Press. New York.
- Dagleish, H.J. and T.M. Woods, "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.", (2008). electronic publication, Published
Bibliography: <http://tiee.ecoed.net/vol/v5/practice/dagleish/abstract.html>.
- Dodds, W.K., "Laws, Theories, and Patterns in Ecology", (2009). Book, Published
Bibliography: University of California Press, Berkeley
- Dodds, W.K., "Humanity's Footprint: Momentum, Impact and our Global Environment", (2008). Book, Published
Bibliography: Columbia University Press, New York
- Reisinger, A.J., "Factors Affecting Denitrification in Headwater Prairie Streams", (2010). Thesis, Published
Bibliography: MS thesis, Kansas State University Manhattan, KS.
- Winders, K., "Ecosystem Processes of Prairie Streams and the Impact of Anthropogenic Alteration on Stream Ecological Integrity", (2010). Thesis, Published
Bibliography: MS thesis, Kansas State University, Manhattan, KS.
- Wilson, I., J. Harrington, Jr., K. McLaughlan, E. Martinson, and S. Hutchinson, "The water budget, climate variability, and climate impacts assessment in Northeast Kansas", (2009). Book, Published
Collection: Papers of the Applied Geography Conferences
Bibliography: pp.189-196

Jumpponen, A., "Analysis of rhizosphere fungal communities using rRNA and rDNA", (2009). Book, Published
 Editor(s): Varma, A. and A.C. Kharkwal
 Collection: Symbiotic Fungi, Soil Biology
 Bibliography: Page 29-40. Springer-Verlag, Berlin

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

Ott, J., "Bud bank morphology, dynamics, and production in perennial grasses", (2009). Thesis, Published
 Bibliography: MS Thesis, Kansas State University, Manhattan, KS. 93 pp

Bowe, S.E., "The influence of host ecology and land cover change on rabies virus epidemiology in the Flint Hills", (2009). Thesis, Published
 Bibliography: PhD Dissertation, Kansas State University, Manhattan, KS

Klug, P.E., "Interactions between grassland birds and their snake predators: the potential for conservation conflicts in the tallgrass prairie", (2009). Thesis, Published
 Bibliography: PhD Dissertation, Kansas State University, Manhattan, KS. 126 pp

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

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

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

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

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

N'Guessan, M., "Effects of grazing on growth and morphology of rhizomatous and caespitose grasses in tallgrass prairie", (2007). Thesis, Published
 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, Kansas State University, Manhattan, KS

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 2008-2009 (the current reporting period), the KNZ program produced or contributed to 95 publications: 75 refereed journal articles (including 10 currently in press), 1 book, 9 book chapters, 9 dissertations and theses, and 1 other publication. 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:

Buis, G.M., J.M. Blair, D.E. Burkepile, C.E. Burns, A.J. Chamerslain, 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*.

Heisler-White, J.L., J.M. Blair, E.F. Kelly, K. Harmoney and A.K. Knapp (In Press). Contingent productivity responses to more extreme rainfall regimes across a grassland biome. *Global Change Biology*.

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.

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.

Smith, M.D., A.K. Knapp and S.L. Collins (In Press). A framework for assessing ecosystem dynamics in response to chronic resource alterations induced by global change. *Ecology*.

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 (2008-2009), over \$12M 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. 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. in press);

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. in press).

In conjunction with our increasing focus on global change ecology, we also continued to use 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 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-convenor 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 Rhee) 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 Brunzell) 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 ft² 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 epifluorescence 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 meetings 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.

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

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 2009-10 year period.

Plant Community and Ecosystem Responses to Long-term Fire and Grazing Treatments.

This study assessed similarities and differences in plant community responses to different long-term fire and grazing regimes. 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. The concept of fire as a global herbivore implies that fire and herbivory may have similar effects on plant functional traits. Using 22 years of data from the Konza LTER program, an NCEAS working group (formed as part of an NCEAS Distributed Graduate Seminar research project led by Scott Collins) tested if trait composition between grazed and burned grassland communities would converge 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 if restoring fire to a previously 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.

Management practices, such as fire and mowing, also affect the distribution and quality of roots and soil C and N in grasslands. As part of the LTER Belowground Plot Experiment, we examined long-term (13 yrs) effects of annual fire and mowing on fine (< 2mm) roots and soil C and N content (Kitchen *et al.* 2009). Using 90 cm deep soil cores, we determined that fire and mowing independently and interactively influenced the quantity and depth distribution of fine root biomass, root C and N concentration, and soil C and N content. Annual burning increased total fine root biomass by 48% and total C storage in roots by 47% compared to unburned unmowed plots, and resulted in a deeper distribution of roots. There was a significant interaction of fire and mowing, whereby mowing reduced root biomass and root C storage by ~30% in annually burned plots, but did not affect total root biomass in unburned plots. Mowing also resulted in shallower distribution of roots regardless of fire treatment. Root N concentration was reduced by 15-25% in plots that were burned, mowed, or both. Mowing effects on soil C and N were restricted to surface soils (0-10 cm), where mowing reduced soil C concentrations by ~20% and N concentrations by 17% regardless of burning treatment. In contrast, burning alone did not significantly influence soil C and N concentrations. In general, root biomass, root C and N mass, and soil C and N concentrations declined with depth, and most responses to burning and mowing exhibited significant interactions

with depth. These results demonstrate that different long-term fire and mowing regimes can significantly alter belowground root biomass and C and N dynamics in grasslands, and in particular at depths in the profile that are not typically sampled. These belowground changes in C and N pools in response to changing disturbance regimes have important consequences for ecosystem-level nutrient budgets and belowground C storage.

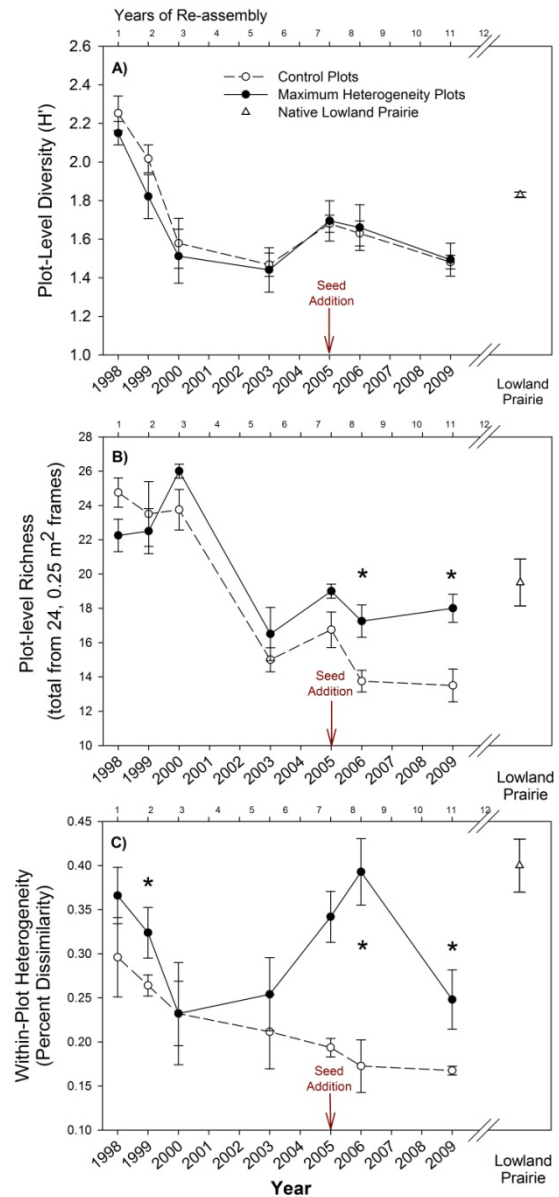
We also completed a recent assessment (Buis *et al.* 2009) of similarities and differences in the responses of North American grasslands (tallgrass prairie) and climatically similar South African savanna grasslands with respect to patterns and controls of annual aboveground net primary productivity (ANPP). It is generally assumed that determinants of ANPP in one region within a biome will operate similarly throughout that biome, as long as physiognomy and climate are broadly consistent. We tested this assumption by quantifying ANPP responses to fire, grazing history and nitrogen (N) addition in North American (NA) and South African (SA) savanna grasslands. We found that total ANPP responded in generally consistent ways to fire, grazing history and N addition on both continents. Annual fire in both NA and SA consistently stimulated total ANPP (28-100%) relative to unburned treatments at sites with deep soils, and had no effect on ANPP in sites with shallow soils. Fire did not affect total ANPP in sites with a recent history of grazing, regardless of whether a single or a diverse suite of large herbivores was present. N addition interacted strongly and consistently with fire regime in both NA and SA. In annually burned sites that were not grazed, total ANPP was stimulated by N addition (29-39%), but there was no effect of N fertilization in the absence of fire. In contrast, responses in forb ANPP to fire, grazing and N additions were somewhat divergent across this biome. Annual fire in NA reduced forb ANPP, whereas grazing increased forb ANPP, but neither response was evident in SA. Thus, despite consistent responses in total ANPP, divergent responses in forb ANPP suggest that other aspects of community structure and ecosystem functioning differ in important ways between these mesic savanna grasslands.

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 C₄ 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 (*in preparation* for R. P. Klopff dissertation, SIUC).

Despite that we have documented intraspecific variation in root architecture and belowground net primary production (Klopf and Baer *in press*), as well as in physiological performance (Lambert et al. *in press*), 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. *submitted*, 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 CO₂ 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).



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 $\delta^2\text{H}$ and $\delta^{18}\text{O}$) between *C. drummondii* and the C₄ 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 C₄ 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 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. Therefore, any global change phenomena (land-use, increased CO₂, 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, submitted) 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 (submitted) 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 (submitted) 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.

Our recently completed grassland microcosm experiment showed that meristem densities (0%, 33%, 66%, or 100% of field density) did not alter seed emergence, establishment, or survivorship of exotic species, however, biomass production of the exotic species was profoundly suppressed by increased bud bank densities. These findings improve our understanding of plant invasion factors that regulate the invasibility of grassland plant communities.

Development of a Plant Trait Database for Konza Prairie.

In 2009-10, Craine, Nippert, and Towne continued to develop the Konza Plant Trait Database for the 593-species Konza vascular flora. First, Craine developed the Konza Unified Taxonomic System (KUTS) which has assigned all species present at Konza a unique numerical ID. Species names are now all ITIS (Integrated Taxonomic Information System) compliant and the KUTS codes can be used to link data from different Konza data sets more consistently. Second, Craine and Adam Skibbe have generated climate envelope data for every species at Konza using the Global Biodiversity Information Facility (GBIF) dataset. These data can be used to test biogeographic patterns of traits and abundance. Third, flowering phenology data continues to be collected in 2010 and have now been compiled for over 350 Konza species. Fourth, Craine and Nippert oversaw a study (Sally Tucker, M.S.) that generated trait data for 125 species grown under controlled conditions. Measured traits relate to the water, nitrogen, and carbon economy of species are being measured. Fifth, through the middle of 2010, Craine and Towne have field-collected leaf trait data on 275 of Konza's herbaceous species. Sixth, the Konza Plant Trait Database also now includes previously collected

trait data such as the mycorrhizal dependence of species (Wilson and Hartnett 1998) and abundance data across watersheds at Konza.

When multiple datasets are assembled, the combined data can provide explanations for species and community responses to environmental variability or changing disturbance regimes, as well as the potential impacts of future climate change on the tallgrass prairie region. For example, using the climate envelope data, we show that a reduction in mean annual precipitation would preferentially remove species that are more abundant in the more productive lowland positions at Konza (Craine et al. *in review b*). As such, decreases in precipitation could reduce productivity not only by reducing water availability, but by removing species that inhabit the most productive areas and respond the most to climate variability. In other efforts, combining trait data and abundance data, physiological drought tolerance is a poor predictor of abundance at Konza. Other traits associated with nutrient availability such as leaf tissue density or mycorrhizal colonization rates are better predictors, which suggests a greater role for nutrient availability than water stress in community structure (Craine and Towne, *in review*; Tucker, *unpublished*).

Grassland Responses to Climatic Variability and Climate Change.

Variable 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) and other rainout shelter approaches (Heisler et al. *in press*). 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 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).

Changing climate could affect the functioning of grassland ecosystems across space and time. How changing climate forcings interact and are shaped by vegetation is an important aspect of the ecosystem ecologic and hydrologic response. We employ a low-dimensional modeling framework to assess the IPCC A1B scenario projections for the Central Plains of the United States to assess mesic grassland functioning; forcings include increased precipitation variability, increased potential evaporation, and earlier growing season onset. Forcings are evaluated by simulations of vegetation water-use efficiency to assess its role on the seasonality of grassland carbon assimilation, and also to explore species-specific responses at the Konza Prairie in North Central Kansas, USA. Results show increased variation in amplitude of water and carbon fluxes between the spring and summer growing season, lower annual carbon assimilation, and increased frequency of water stress conditions. Vegetation responses suggest climate change will be strongest at the species-level. This is important

for understanding the effects of climate change on grassland functioning and for exploring the mechanisms shaping growing season dynamics.

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. in press). 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 Brunzell. 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 C₄ 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). 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 are completing 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, and 4) corresponding changes in invertebrate communities related to changes in food availability.

We have recently synthesized our participation in the LINX II (Lotic Intersite Nitrogen eXperiment II) and found that 1) prairie streams are highly retentive of nitrogen, 2) both heterotrophic and autotrophic components of the food web are co-limited by nitrogen and phosphorus (Johnson et al. 2009), 3) that nitrogen pollution saturates the ability of prairie streams to remove nitrogen (Hall et al. 2009, Mulholland et al. 2009, Knapp et al. 2010), and 4) that there are fundamental differences in the functional responses to short and long term (chronic and acute) nitrogen pollution events (O'Brien and Dodds 2010).

Finally, preliminary results from a new graduate student project (by grad student Erika Martin) indicate that there are interactions between cohorts within a central stoneroller species (*Campostoma anomalum*). Initial long-term data analyses (e.g., Principle Components Analysis, regression analyses) have found slight relationships between fish density and both spring and fall flow rates, however these were not significant. Thus, we believe other factors besides hydrology (e.g., migration) might influence the fish community assemblages throughout the stream. Studies conducted in the experimental streams, the comprehensive Kings Creek survey, as well as long-term data will be used to further analyze the variability in stream fish assemblages.

Konza Prairie Groundwater Studies.

Macpherson (2009a) published a manuscript (1) showing the general distribution of CO₂ in groundwater and (2) constraining the world-wide annual CO₂ release to the atmosphere when that groundwater is pumped from the ground, using Konza data as one of the extreme water-chemistry types. Macpherson (2009b) also published and presented some of the data showing the similarity in the atmospheric and groundwater CO₂ annual patterns, suggesting the soil as a zone of amplification of the atmospheric cycle, and suggesting that downward flux of CO₂ from the soil is significant.

Breanna Huff, University of Kansas, completed her Honors' Thesis (undergraduate), 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). Karen Ohmes completed her undergraduate research project, 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.

Finally, new data (Macpherson, unpublished) show that several low-concentration dissolved species in groundwater at Konza N04d have long-term trends showing decline in concentration, which is the opposite of the trend of the high-concentration dissolved species. This supports a change in weathering regime, and may support a switch from more dolomite-dominated water chemistry to more calcite-dominated water chemistry.

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. 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 nutrient uptake: The results of a recent cross-site study examining mycorrhizal symbiosis in Konza Prairie LTER, Cedar Creek LTER, and Fermi National Lab has been recently published in PNAS (Johnson et al. 2010). This study examined local adaptation in mycorrhizal symbioses and results indicated that local adaptations between plants and their mutualistic fungi maximize nutrient uptake and plant fitness. This study tested two hypotheses: (1) Mycorrhizas improve plant fitness by increasing the uptake of either phosphorus or nitrogen, whichever nutrient is most limiting to plant growth; (2) AM fungi adapt to each other and to their local soil such that more beneficial mutualisms should occur in local (home) combinations of plants, fungi and soil than in non-local (away) combinations. Ecotypes of *Andropogon gerardii*, a dominant grass of Tallgrass Prairie, were obtained from three representative sites spanning much of the geographical range of this species. These sites included phosphorus-limited (Konza Prairie LTER and Fermi National Lab) and nitrogen-limited soils (Cedar Creek LTER). Ecotypes were grown with all possible home and away combinations of soils and AM fungal communities. Grasses grown in home soil and inoculated with home AM fungi produced more arbuscules and extraradical hyphae than those grown in away combinations. Extramatrical hyphae (EMH) and arbuscules were strongly positively associated with tissue nitrogen at Cedar Creek - the nitrogen limited site; but weakly correlated at Fermi or Konza –

the phosphorus limited sites. In contrast, EMH and arbuscules were strongly related to tissue phosphorus at Fermi and Konza but not at Cedar Creek. These 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.

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. Seeds of 12 different forb species varying in degree of mycorrhizal dependence were added to established grass-dominated plots. Replicate plots were treated bi-weekly with a soil drench of fungicide over 4 growing seasons, and compared to non-treated control plots to assess the role of AMF in affecting plant species composition, productivity, leaf tissue quality, and diversity in restored tallgrass prairie. Fungicide applications successfully reduced mycorrhizal colonization of grass roots to approximately 60 – 80% relative to roots in control plots. 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.

Mycorrhizae and invasive grasses: Scientists at Oklahoma State University (Gail Wilson and Karen Hickman) have recently completed a cross site project to investigate plant-soil feedback mechanisms that promote successful invasions by non-native warm-season grass species into grasslands dominated by warm-season grasses across the Great Plains. There is concern that these exotic grasses reduce ecosystem services provided by native rangelands. Invasion by these non-native warm-season grasses result in the loss of native plant diversity (especially the forb component) and concomitant losses in wildlife habitat, with large expanses of invaded areas altering the window of forage production availability. Soil was collected from areas invaded by an exotic grass (Old World Bluestem) at two prairies in Kansas: 1) Konza Prairie Biological Station, Manhattan; 2) Fort Hays State University Albertson Pasture, Hays; and two in Oklahoma: 3) Marvin Klemme Range Research Area, Bessie; 4) Stillwater Research Range, Stillwater. In a series of greenhouse studies, the presence of OWB resulted in substantially reduced above- and belowground growth of native grasses, and significant reductions in mycorrhizal fungal colonization. Further, biomass production of native species was consistently reduced when planted into soil collected from beneath or between the exotic grasses, as compared to native prairie soil that had been collected in adjacent areas to the OWB. We observed a strong positive relationship between AM colonization and plant biomass production. This was consistent for both native species (big bluestem and little bluestem) and across all four prairie sites. These alterations in fungal symbiotic activity may provide feedback responses by directly benefiting the invader, as compared to the native plants, or indirectly by altering the abundance of nutrients, which may interact to promote further invasion.

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.

Analyses by Jumpponen and colleagues of the fungal communities that inhabit oaks in urban and native stands indicate that both phyllosphere and rhizosphere communities are hyperdiverse (~1,000 taxa), distinct among the urban and native stands (Jumpponen & Jones 2009, Jumpponen et al. 2010a) and seasonally dynamic (Jumpponen & Jones 2010, Jumpponen et al. 2010a). These hyperdiverse communities maintain higher richness and diversity in the native stands and several taxa occur preferentially in the native stands. While the mechanisms underlying these differences require further empirical testing, our adoption of Inductively Coupled Plasma Mass Spectrometry (ICP-MS) provided a short list of macronutrients (N, K, and S, but not P) and trace elements or heavy metals (B, Ce, Mn, Pb, Sr, Y) that are correlated with the urban environments. Among those, model selection exercises suggest that the dominant fungal species are likely most responsive to heavy metal enrichment (Jumpponen et al. 2010b).

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 Upland Sandpipers and Greater Prairie-chickens at Konza Prairie included five publications, one manuscript under review, and a completed dissertation. Our 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. *In Press*). 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).

Population studies of Greater Prairie-chickens at Konza Prairie have included a 3-year behavioral study and 4-year demographic study. In a field experiment where we manipulated testosterone levels of males attending communal display arena (or leks), we found that testosterone plays a key role in mediating tradeoffs between reproductive effort and survival, with important impacts on lifetime reproductive success (Augustine et al. *In Press*). Demographic studies have included long-term lek surveys at Konza Prairie, and comparative population studies at Konza Prairie and two other sites in the Flint and Smoky Hills (McNew 2010). Application of new occupancy models based on mark-

recapture statistics revealed that rangeland management under the LTER program has impacted prairie-chickens populations over a 28-year period (McNew et al. *In Review*). Probability of colonization of a site was negatively impacted by increases in woody vegetation whereas probability of extirpation was influenced by interactions between fire and grazing treatments. Demographic data from our intensive population studies have showed that ongoing population declines are due to depressed reproductive output, which are a function of low rates of survival among nests, broods, and incubating females caused by losses to predation (McNew et al. *In Press a*). Low productivity appears to be the result of intensification of cattle production on rangelands in Kansas, coupled with long-term recovery of mesocarnivore predators which benefit from increases in woody vegetation. Regional comparisons of prairie-chicken demography across an ecological gradient of habitat fragmentation indicate that changes in predation pressure have evolutionary consequences for prairie-chickens with changes in reproductive effort (McNew et al. *In Press b*).

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 three ongoing studies.

Long-term studies show that house mice (*Mus musculus*) are extremely uncommon in tallgrass prairie (only about one individual captured per 10,000 trap nights). Despite their low numbers, summer precipitation significantly influenced autumn use of tallgrass prairie by house mice (0 after the 9 driest summers, 9 after 10 intermediate summers, and 6 after 10 wettest summers). Previously, we have shown that weather impacts abundances of short-tailed shrews (negative effect of arid conditions; Matlack et al. 2002), hispid cotton rats (negative effect of cold winters; Rehmeier et al. 2005) and prairie voles (higher amplitude of cycle, especially peaks, associated with moist runs of years; unpublished data of Kaufman and Kaufman). Captures of house mice on Konza Prairie were distributed broadly in both space and time and lacked predictability (i.e., exhibited an “anti-nested” distribution of captures), whereas native small mammals on Konza Prairie tend to show nested patterns in space and time (Kaufman et al. 2000). These and other patterns suggest that most house mice are transients and that individuals present do not represent a low-density resident population. Distribution and abundance of house mice also imply that this introduced species is unlikely to become invasive in native tallgrass prairie or in other grasslands in the Great Plains.

The thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) is the most widespread ground-dwelling squirrel in the Great Plains and most common in the Flint Hills region. It is one of the rodents that hibernate during the cold winter months on Konza Prairie. The general dogma suggests that these adult ground squirrels are active from March to mid-October, and might estivate during the hottest part of the summer (Bee et al. 1981). Our long-term studies and an intensive 5-year study on Konza Prairie show that this is not true. Rather, adult males emerge from hibernation in late March-early April (timing of emergence has a weather component and is not strictly related to photoperiod) about 2 weeks before most adult females. Mating occurs within the first few days of female emergence; young are born in late May-early June. The adult males put on fat after the mating season and go into hibernation in July with adult females immersing shortly thereafter. The only ground squirrels observed aboveground after July are exceptionally-stressed adults and young of the year, which go into hibernation in October-November (again timing has a weather or productivity component). The observed pattern that we have seen in thirteen-lined ground squirrels on Konza Prairie has been reported in only one other species, Richardson’s ground squirrel, which occurs in the far northern plains of Alberta.

Season of fire affects abundance of deer mice (*Peromyscus maniculatus*), age structure, proportion of reproductive females, and body size of adult males and non-reproductive females. Significantly fewer deer mice occur in the spring treatment than in the fall and winter burns in March, but this difference did not occur in October. Furthermore, abundances of deer mice differed between October and March in the spring burns, but not in the fall and winter burns. Age structure also differed between the three burn types. The greatest difference in proportions was found in spring burns, as the percent of juveniles (an index of reproductive output) significantly decreased from 12% in October to only 1% in March populations. Percent of juveniles also decreased significantly in fall (8% to 2%) and winter (7% to 2%) burns from October to March, but these differences were not as large. Likewise, the percent of reproductive (i.e., pregnant and nursing) females decreased greatly from October (35%) to March (15%) in populations of deer mice in spring burns, whereas this pattern was not found in fall (42% and 43%) and winter (24% and 42%) burns, which did not differ from each other. Finally, body size of males and non-reproductive females were significantly larger on winter burns in March than they were on fall and spring burns. These patterns are interesting in that the spring burns appear to be the most benign habitat among the three burn types in March when the most differences are seen among burn types for deer mice. Spring burns provide small mammals overhead cover and have done so for 11 months since the previous fire, whereas fall and winter burns have been devoid of vegetation for 2-4 months and provide no cover from predators. We have shown previously that deer mice don't require cover and speculate that their primary predators are snakes which are inactive from October to March.

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 Oceanography* (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*).

Below is a list of Konza Prairie LTER publications for the period January 2009 – present (August 13, 2010).

Publications - 2009

Baer, S.G., D. Engle, J.M.H. Knops, K.A. Langeland, B.D. Maxwell, F.D. Menalled, and A. Symstad. 2009. Non-target and invasive species in rehabilitated production systems: Ecological impacts, management and future use. *Environmental Management* **43**:189-196.

Banner, E.B.K., A.J. Stahl, and W.K. Dodds. 2009. Stream discharge and riparian land use influence in-stream concentrations and loads of phosphorus from Central Plains watersheds. *Environmental Management* **44**:552-565.

Bertrand, K.N., K.B. Gido, W.K. Dodds, J.N. Murdock, and M.R. Whiles. 2009. Disturbance frequency and functional identity mediate ecosystem processes in prairie streams. *Oikos* **118**:917-933.

Buis, G.M., J.M. Blair, D.E. Burkepille, C.E. Burns, A.J. Chamberlain, P. Chapman, S.L. Collins, R.W.S. Fynn, N. Govender, K. Kirkman, M.D. Smith and, A.K. Knapp. 2009. Controls of aboveground net primary production in mesic grasslands and savannas: An interhemispheric comparison. *Ecosystems* **12**:982-995.

Casey, A.E., K. Jones, B.K. Sandercock, and S.M. Wisely. 2009. Heteroduplex molecules cause sexing errors in a standard molecular protocol for avian sexing. *Molecular Ecology Resources* **9**:61-65.

Cheatham, M.R., M.N. Rouse, P.D. Esker, S. Ignacio, W. Pradel, R. Raymundo, A.H. Sparks, G.A. Forbes, T.R. Gordon, and K.A. Garrett. 2009. Beyond yield: Plant disease in the context of ecosystem services. *Phytopathology* **99**:1228-1236.

Craine, J.M., E.G. Towne, A. Joern, and R.G. Hamilton. 2009. Consequences of climate variability for the performance of bison in tallgrass prairie. *Global Change Biology* **15**:772-779.

Craine, J.M., R. Spurr, K.K. McLauchlan, and N. Fierer. 2009. Landscape-level variation in temperature sensitivity of soil organic carbon decomposition. *Soil Biology & Biochemistry* **42**:373-375.

Dalgleish, H.J. and D.C. Hartnett. 2009. The effects of fire frequency and grazing on tallgrass prairie productivity and plant composition are mediated through bud bank demography. *Plant Ecology* **201**:411-420.

Dodds, W.K. 2009. *Laws, Theories, and Patterns in Ecology*. University of California Press, Berkeley, CA.

Dragoo, J.W., K.E. Coan, K.A. Moore, S.E. Henke, R.C. Fleisher, and S.M. Wisely. 2009. Polymorphic microsatellite markers for the striped skunk, *Mephitis mephitis*, and other mephitids. *Molecular Ecology Resources* **9**:383-385.

Evans-White, M.A., W.K. Dodds, D.G. Huggins, and D.S. Baker. 2009. Thresholds in macroinvertebrate biodiversity and stoichiometry across water-quality gradients in Central Plains (USA) streams. *Journal of the North American Benthological Society* **28**:855-868.

Gadbury, G.L., K.A. Garrett and D.B. Allison 2009. Challenges and approaches to statistical design and inference in high dimensional investigations. Page 181-206. In D.A. Belostotsky (eds.) *Plant Systems Biology, Methods in Molecular Biology Series*. The Humana Press Inc.. Totowa, NJ.

Garrett, K.A., M. Nita, E.D. De Wolf, L. Gomez and A.H. Sparks. 2009. Plant pathogens as indicators of climate change. Page 425-437. In T. Letcher (eds.) *Climate and Global Change: Observed Impacts on Planet Earth*. Elsevier.

Gibson, D.J. 2009. *Grasses and Grassland Ecology*. Oxford University Press, Oxford, UK.

Grace, T., A. Joern, S.J. Brown, J.L. Apple, and S.M. Wisely. 2009. Highly polymorphic microsatellites in the North American rangeland grasshopper *Hesperotettix viridis*. *Journal of Orthoptera Research* **18**:19-21.

Hall Jr., R.O., J.L. Tank, D.J. Sobota, P.J. Mulholland, J.M. O'Brien, W.K. Dodds, J.R. Webster, H.M. Valett, G.C. Poole, B.J. Peterson, J.L. Meyer, W.H. McDowell, S.L. Johnson, S.K. Hamilton, N.B. Grimm, S.V. Gregory, C.N. Dahm, L.W. Cooper, L.R. Ashkenas, S.M. Thomas, R.W. Sheibley, J.D. Potter, B.R. Niederlehner, L.T. Johnson, A.M. Helton, C.M. Crenshaw, A.J. Burgin, M.J. Bernot, J.J. Beaulieu, and C.P. Arango. 2009. Nitrate removal in stream ecosystems measured by ¹⁵N addition experiments: Total uptake. *Limnology and Oceanography* **54**:653-665.

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**:1320-1338.

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.

Johnson, L.T., J.L. Tank, and W.K. Dodds. 2009. The influence of land use on stream biofilm nutrient limitation across eight North American ecoregions. *Canadian Journal of Fisheries and Aquatic Sciences* **66**:1081-1094.

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.

Jumpponen, A. 2009. Analysis of rhizosphere fungal communities using rRNA and rDNA. Page 29-40. *In* Varma, A. and A.C. Kharkwal (eds.) *Symbiotic Fungi, Soil Biology*. 18. Springer-Verlag, Berlin.

Jumpponen, A. and K.L. Jones. 2009. Massively parallel 454-sequencing of *Quercus macrocarpa* phyllosphere fungal communities indicates reduced richness and diversity in urban environments. *New Phytologist* **184**:438-448.

Kaufman, D.W. and G.A. Kaufman. 2009. The woodland vole on Konza Prairie Biological Station, Kansas. *Transactions of the Kansas Academy of Science* **112**:229-230.

Kitchen, D.J., J.M. Blair, and M.A. Callahan, Jr.. 2009. Annual fire and mowing alter biomass, depth distribution, and C and N content of roots and soil in tallgrass prairie. *Plant and Soil* **323**:235-247.

Knapp, C.W., W.K. Dodds, K.C. Wilson, J.M. O'Brien, and D.W. Graham. 2009. Spatial heterogeneity of denitrification genes in a highly homogenous urban stream. *Environmental Science & Technology* **43**:4273-4279.

Macpherson, G. L. 2009. CO₂ distribution in groundwater and the impact of groundwater extraction on the global C cycle. *Chemical Geology* **264**:328-336.

Margosian, M.L., K.A. Garrett, J.M.S. Hutchinson, and K.A. With. 2009. Connectivity of the

- American agricultural landscape: Assessing the national risk of crop pest and disease spread. *Bioscience* **59**:141-151.
- McCulley, R.L., I.C. Burke, and W.K. Lauenroth. 2009. Conservation of nitrogen increases with precipitation across a major grassland gradient in the Central Great Plains of North America. *Oecologia* **159**:571-581.
- McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock. 2009. Estimating the stage of incubation for nests of Greater Prairie-chickens using egg flotation: a float curve for grouse. *Grouse News* **38**:12-14.
- Middendorf, G., T.A. Becerra, and D. Cline. 2009. Transition and resilience in the Kansas Flint Hills. *Online Journal of Rural Research and Policy* **4.3**:1-28.
- Molecular Ecology Resources Primer Development Consortium et al. 2009. Permanent Genetic Resources added to Molecular Ecology Resources Database 1 May 2009 - 31 July 2009. *Molecular Ecology Resources* **9**:1460-1466.
- Morisette, J.T., A.D. Richardson, A.K. Knapp, J.I. Fisher, E.A. Graham, J. Abatzoglou, B.E. Wilson, D.D. Breshears, G.M. Henebry, J.M. Hanes, and L. Liang. 2009. Learning the rhythm of the seasons in the face of global change: phenological research in the 21st Century. *Frontiers in Ecology and the Environment* **7**:253-260.
- Mulholland, P.J., R.O. Hall Jr., D.J. Sobota, W.K. Dodds, S.E.G. Findlay, N.B. Grimm, S.K. Hamilton, W.H. McDowell, J.M. O'Brien, J.L. Tank, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, S.V. Gregory, S.L. Johnson, J.L. Meyer, B.J. Peterson, G.C. Poole, H.M. Valett, J.R. Webster, C.P. Arango, J.J. Beaulieu, M.J. Bernot, A.J. Burgin, C.L. Crenshaw, A.M. Helton, L.T. Johnson, B.R. Niederlehner, J.D. Potter, R.W. Sheibley, and S.M. Thomas. 2009. Nitrate removal in stream ecosystems measured by ¹⁵N addition: Denitrification. *Limnology and Oceanography* **54**:666-680.
- Nippert, J.B., P.A. Fay, J.D. Carlisle, A.K. Knapp, and M.D. Smith. 2009. Ecophysiological responses of two dominant grasses to altered temperature and precipitation regimes. *Acta Oecologia* **35**:400-408.
- Reed, H.E., J.M. Blair, D. Wall, and T.R. Seastedt. 2009. Impacts of management legacies on litter decomposition in response to reduced precipitation in a tallgrass prairie. *Applied Soil Ecology* **42**:79-85.
- Rivers, J.W.. 2009. Parent-absent begging in the Brown-headed Cowbird (*Molothrus ater*): the role of short-term need and nestmate size. *Behavioral Ecology and Sociobiology* **63**:707-717.
- Roth II, T.C. and V.V. Pravosudov. 2009. Hippocampal volumes and neuron numbers increase along a gradient of environmental harshness: a large-scale comparison. *Proceedings of the Royal Society B* **276**:401-405.
- 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.
- Wilgers, D.J. and E.A. Horne. 2009. Differential responses to chemical stimuli in conspecific fecal

pellets by an iguanid lizard *Crotaphytus collaris*. *Journal of Ethology* **27**:157-163.

Williams M.A. and K. Xia. 2009. Characterization of the water soluble soil organic pool following the rewetting of dry soil in a drought-prone tallgrass prairie. *Soil Biology & Biochemistry* **41**:21-28.

Wilson, G.W.T., C.W. Rice, M.C. Rillig, A. Springer, and D.C. Hartnett. 2009. Soil aggregation and carbon sequestration are tightly correlated with the abundance of arbuscular mycorrhizal fungi: results from long-term field experiments. *Ecology Letters* **12**:452-461.

Wilson, K.C. and W.K. Dodds. 2009. Centimeter-scale stream substratum heterogeneity and metabolic rates. *Hydrobiologia* **623**:53-62.

Woods, T.M., D.C. Hartnett, and C.J. Ferguson. 2009. High propagule production and reproductive fitness homeostasis contribute to the invasiveness of *Lespedeza cuneata* (Fabaceae). *Biological Invasions* **11**:1913-1927.

Worapong, J., S.P. Dendy, Z. Tang, D.J. Awl, and K.A. Garrett. 2009. Limiting temperatures for urediniospore germination are low in a systemic rust fungus of tallgrass prairie. *Mycologia* **101**:390-394.

Publications 2010

Bernot, M.J., D.J. Sobota, R.O. Hall Jr., P.J. Mulholland, W.K. Dodds, J.R. Webster, J.L. Tank, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, S.V. Gregory, N.B. Grimm, S.K. Hamilton, S.L. Johnson, W.H. McDowell, J.L. Meyer, B. Peterson, G.C. Poole, H.M. Valett, C. Arango, J.J. Beaulieu, A.J. Burgin, C. Crenshaw, A.M. Helton, L. Johnson, J. Merriam, B.R. Niederlehner, J.M. O'Brien, J.D. Potter, R.W. Sheibley, S.M. Thomas, K. Wilson. 2010. Inter-regional comparison of land-use effects on stream metabolism. *Freshwater Biology* **55**:1874-1890.

Bouska, W.W. and C.P. Paukert. 2010. Road crossing designs and their impact on fish assemblages of Great Plains streams. *Transactions of the American Fisheries Society* **139**:214-222.

Bremer, D.J. and J.M. Ham. 2010. Net carbon fluxes over burned and unburned native tallgrass prairie. *Rangeland Ecology & Management* **63**:72-81.

Craine, J.M., E.G. Towne, and J.B. Nippert. 2010. Climate controls on grass culm production over a quarter century in a tallgrass prairie. *Ecology* **91**:2132-2140.

Dodds, W.K., W.H. Clements, K.B. Gido, R.H. Hilderbrand, and R.S. King. 2010. Thresholds, breakpoints, and nonlinearity in freshwaters as related to management. *Journal of the North American Benthological Society* **29**:988-997.

Hartnett, D.C. 2010. Into Africa: Promoting international ecological research and training in the developing world. *Bulletin of the Ecological Society of America* **91**:202-206.

Ippolito, J.A., S.W. Blecker, C.L. Freeman, R.L. McCulley, J.M. Blair, and E.F. Kelly. 2010. Phosphorus biogeochemistry across a precipitation gradient in grasslands of central North America. *Journal of Arid Environments* **74** :954-961.

- Jangid, K., M.A. Williams, A.J. Franzluebbbers, J.M. Blair, D.C. Coleman, and W.B. Whitman. 2010. Development of soil microbial communities during tallgrass prairie restoration. *Soil Biology & Biochemistry* **42**:302-312.
- 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* **107**:2093-2098.
- 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.
- Jumpponen, A., K.L. Jones, J.D. Mattox, and C. Yeage. 2010. Massively parallel 454-sequencing of fungal communities in *Quercus* spp. ectomycorrhizas indicates seasonal dynamics in urban and rural sites. *Molecular Ecology* **19**:41-53.
- Klug, P.E., S.L. Jackrel, and K.A. With. 2010. Linking snake habitat use to nest predation risk in grassland birds: the dangers of shrub cover. *Oecologia* **162**:803-813.
- Mandyam, K., T. Loughlin, and A. Jumpponen. 2010. Isolation and morphological and metabolic characterization of common endophytes in annually burned tallgrass prairie. *Mycologia* **102**:813-821.
- Melzer, S.E., A.K. Knapp, R.W.S. Fynn, K.P. Kirkman, M.D. Smith, J.M. Blair, and E.F. Kelly. 2010. Fire and grazing impacts on silica production and storage in grass dominated ecosystems. *Biogeochemistry* **97**:263-278.
- Murdock, J.M., K.B. Gido, W.K. Dodds, K.N. Bertrand, and M.R. Whiles. 2010. Consumer return chronology alters recovery trajectory of stream ecosystem structure and function following drought. *Ecology* **91**:1048-1062.
- O'Brien, J.M. and W.K. Dodds. 2010. Saturation of NO₃⁻ uptake in prairie streams as a function of acute and chronic N exposure. *Journal of the North American Benthological Society* **29**:627-635.
- Presley, D.R., P.E. Hartley and M.D. Ransom. 2010. Mineralogy and morphological properties of buried polygenetic paleosols formed in late quaternary sediments on upland landscapes of the central plains, USA. *Geoderma* **154**:508-517.
- Rivers, J.W., P.S. Gipson, D.P. Althoff, and J.S. Pontius. 2010. Long-term community dynamics of small landbirds with and without exposure to extensive disturbance from military training activities. *Environmental Management* **45**:203-216.
- Rivers, J.W., W.E. Jensen, K.L. Kosciuch, and S.I. Rothstein. 2010. Community-level patterns of host use by the Brown-headed Cowbird (*Molothrus ater*), a generalist brood parasite. *Auk* **127**:263-273.
- Roth, T.C., L.D. LaDage, and V.V. Pravosudov. 2010. Learning capabilities enhanced in harsh environments: a common garden approach. *Proceedings of the Royal Society B*: doi:10.1098/rspb.2010.0630.

Saleh, A.A., H.U. Ahmed, T.C. Todd, S.E. Travers, K.A. Zeller, J.F. Leslie, and K.A. Garrett. 2010. Relatedness of *Macrophomina phaseolina* isolates from tallgrass prairie, maize, soybean, and sorghum. *Molecular Ecology* **19**:79-91.

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.

Strum, K.M., M.J. Hooper, K.A. Johnson, R.B. Lanctot, M.E. Zaccagnini, and B.K. Sandercock. 2010. Exposure of migratory nonbreeding shorebirds to cholinesterase-inhibiting contaminants in the Western Hemisphere. *The Condor* **112**:15-28.

Taylor, E.B. and M.A. Williams. 2010. Microbial protein in soil: influence of extraction method and C amendment on extraction and recovery. *Microbial Ecology* **59**:390-399.

Travers, S.E., Z. Tang, D. Caragea, K.A. Garrett, S.H. Hulbert, J.E. Leach, J. Bai, A. Saleh, A.K. Knapp, P.A. Fay, J. Nippert, P.S. Schnable, and M.D. Smith. 2010. Variation in gene expression of *Andropogon gerardii* in response to altered environmental conditions associated with climate change. *Journal of Ecology* **98**:374-383.

Publications In Press (as of August 10, 2010)

Augustine, J.K., J.J. Millspaugh, and B.K. Sandercock (*In Press*). Testosterone: a proximate factor mediating mating success in male Greater Prairie-Chickens? *Studies in Avian Biology*.

Apple J., T. Grace, A. Joern, P. St. Amand, and S.M. Wisely (*In Press*). Comparative genome scan detects host-related divergent selection in the grasshopper *Hesperotettix viridis*. *Molecular Ecology*.

Casey, A.E., B.K. Sandercock, and S.M. Wisely (*In Press*). Genetic parentage and local population structure in the socially monogamous Upland Sandpiper. *Condor*.

Craine, J.M. and E.G. Towne (*In Press*). High leaf tissue density grassland species consistently more abundant across topographic and disturbance contrasts in a North American tallgrass prairie. *Plant and Soil*.

Craine, J.M. and R.D. Jackson (*In Press*). Nitrogen and phosphorus limitation in soils from 98 North American grasslands. *Plant and Soil*.

Craine, J.M., A.J. Elmore, K.C. Olson, and D. Tolleson (*In Press*). Climate change and nutritional stress in cattle. *Global Change Biology*.

Gido, K.B., W.K. Dodds, and M. Eberle (*In Press*). Retrospective analysis of fish community change during a half-century of landuse and streamflow changes. *Journal of the North American Benthological Society*.

Grace, T., F. Dowell, A. Joern, S.M. Wisely, S.J. Brown, and E. Maghirang (*In Press*). Divergent host plant adaptation drives the evolution of reproductive isolation in the grasshopper *Hesperotettix viridis* (Orthoptera: Acrididae). *Biological Journal of the Linnaean Society*.

Gregory, A.J., L.B. McNew, T.J. Prebyl, B.K. Sandercock, and S.M. Wisely (*In Press*). A multiscale hierarchical modeling approach to mapping lekking habitats of Greater Prairie-Chickens in eastern Kansas. *Studies in Avian Biology*.

Jumpponen, A., K. Keating, G.L. Gadbury, K.L. Jones, and J.D. Mattox (*In Press*). Multi-element fingerprinting and high throughput sequencing identify multiple elements that affect fungal communities in *Quercus macrocarpa* foliage. *Plant Signaling and Behaviour*.

Jumpponen, A., K.L. Jones, and J.M. Blair (*In Press*). Vertical distribution of fungal communities in tallgrass prairie soil. *Mycologia*.

Kaufman, D.W., G.A. Kaufman, and D.E. Brillhart (*In Press*). Small mammals as winter prey of long-eared owls in Kansas. *Transactions of the Kansas Academy of Science*.

Kaufman, G.A. and D.W. Kaufman (*In Press*). The meadow jumping mouse on Konza Prairie Biological Station, Kansas. *Transactions of the Kansas Academy of Science*.

Kaufman, G.A., D.M. Kaufman, and D.W. Kaufman (*In Press*). "Treated" versus "new" traps--does chronic applications of disinfectant to live traps reduce rodent trappability? *Southwestern Naturalist*.

Klopf, R.P. and S.G. Baer (*In Press*). Root dynamics of cultivar and non-cultivar population sources of three dominant grasses during initial establishment of tallgrass prairie. *Restoration Ecology*.

Lambert, A.M., S.G. Baer, and D.J. Gibson (*In Press*). Intraspecific variation in ecophysiology of three dominant prairie grasses used in restoration: cultivar vs. non-cultivar population sources. *Restoration Ecology*.

Loaiza, V., J.L. Jonas, and A. Joern (*In Press*). Local distributions of grasshoppers (Orthoptera: Acrididae) respond to foliar nitrogen but not phosphorus in native grassland. *Insect Science*.

McCain, K.N.S., S.G. Baer, J.M. Blair, and G.W.T. Wilson (*In Press*). Dominant grasses suppress local diversity in restored tallgrass prairie. *Restoration Ecology*.

McLauchlan, K.K., C.J. Ferguson, I.E. Wilson, T.W. Ocheltree, and J. M. Craine (*In Press*). Declining nitrogen availability over thirteen decades in central North American grasslands. *New Phytologist*.

McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock (*In Press*). Reproductive chronology of Greater Prairie-Chickens in Kansas. *Studies in Avian Biology*.

McNew, L.B., A.J. Gregory, S.M. Wisely, and B.K. Sandercock (*In Press*). Evidence of human-mediated life-history evolution in Greater Prairie-Chickens. *Studies in Avian Biology*.

Peters D.P.C., B.T. Bestelmeyer, A.K. Knapp, J.E. Herrick, H.C. Monger and K.M. Havstad *In Press*. Approaches to predicting broad-scale regime shifts using changing pattern-process relationships across scales. Page -. In S. Miao, S. Carstenn and M. Nungesser (eds.) *Real World Ecology: Design and Analyses of Large-Scale and Long-Term Research*. Springer-Verlag, NY.

Background on the Konza Prairie LTER Program

The Konza Prairie LTER Program is a comprehensive, interdisciplinary research program designed to contribute to synthetic ecological studies and conceptual and theoretical advances in the field of ecology, and to provide 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 >25 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.

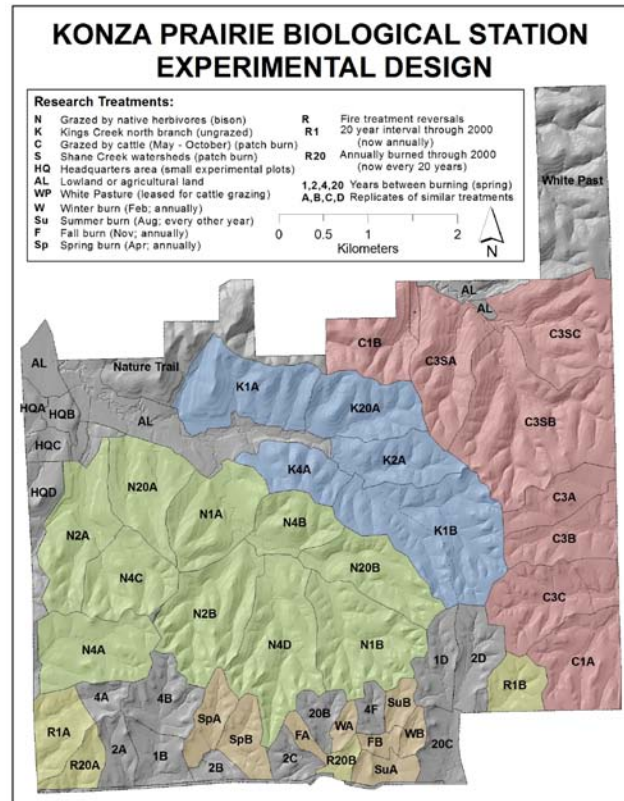


Figure 1. Konza Prairie site experimental design, and watershed-level fire and grazing treatments. Watersheds with native ungulate (bison) grazing ('N') are light green, and cattle-grazed watersheds ('C') are red. All other watersheds are ungrazed. Numbers designate fire return intervals, and the last 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 second year (2009-2010) 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 (2009-2010):

Fire Ecology in Tallgrass Prairie.

In 2009-2010, 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, 10 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 currently being used for studies of genetic plant population structure and community invasibility by graduate students from Yale, for studies of bird population dynamics by graduate students from Cornell and the University of Kentucky, and for studies of climate change by a student from 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 2010 (the “isoscapes” study), and preliminary results were presented at the 2009 spring meeting of the American Geophysical Union. The “season-of-fire” experiments 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 has been exacerbated by the relatively narrow window during which management-related (cattle pasture) spring burning has historically taken place in the Flint



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.

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 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).

We 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 2010 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. This tower is operated by LTER collaborator Nate Brunsell, and will provide important new information on C flux in an area with higher annual precipitation than the Konza site.

We continued the “reversal of fire treatments” experiment (fire treatments reversed on two watersheds that were previously annually burned and two unburned watersheds) to assess the legacy effects of prior fire histories on response to a change in fire regimes. 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. In 2008, this study was the focus of research for a visiting MS student (Elske Kopenaal) from Groningen University (The Netherlands). Her project included a retrospective analysis of LTER plant community data on the fire reversal watersheds, as well as an intensive resampling of previously censused shrub islands (Heisler et al. 2003, 2004). In 2010, we are re-sampling woody plant using GPS and field sampling methods on these watersheds. 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.

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 2008-10, 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 will allow 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.

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 2008-09 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 2009-10, University of Mexico graduate student Sally Koerner was funded by an NSF Doctoral Dissertation Improvement Grant to expand her research at Konza Prairie and in Kruger National Park, South Africa. Her dissertation 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.

To increase our understanding of the spatio-temporal dynamics of fire-grazing interactions, we initiated a new patch-burn grazing experiment during LTER VI. This entails 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. 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 and the initiation of new stocking rates to complete the proposed experimental design. The patch-burn 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.

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). 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



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.

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 2009-10 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.

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. A new LTER study is 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 3) 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 6 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.

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, topographic variability in primary productivity, improve hydrologic modeling, and enhance the interpretation of data from remote sensing platforms and flux towers. A 10-station sensor network was deployed in 2008 to measure the spatial variation in the surface energy balance in an annually-burned core LTER watershed at Konza Prairie. Stations in the sensor network are distributed at 30- to 50-m intervals between two eddy covariance towers in an annually burned, ungrazed watershed (one tower at an upland and lowland topographic position, respectively). Measurements at each station included: air and soil 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 included canopy reflectance, canopy size, LAI, plant heights, leaf water potentials, and instantaneous measurements of soil and leaf gas exchange. 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 across an apparently homogenous landscape (a single watershed, and (2) plant physiological responses to environmental variability vary by species, location, and time of summer, reinforcing the specificity of micro-site environmental conditions as a key driver of plant community structure in this grassland.

Physiological and 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. 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. 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.

Restoration Ecology and Grasslands.

The Konza Prairie LTER program includes a unique legacy of restoration projects and continues to address fundamental and timely issues in restoration ecology such as the roles soil heterogeneity, seed sources of, and climate in steering community and ecosystem recovery. Multiple field experiments are being continued during LTER VI to elucidate factors that constrain species diversity in restored communities to advance our understanding of community assembly rules in the context of restoration. We have continued to measure and synthesize long-term responses of community composition in a restoration experiment initiated in 1998 at the Konza LTER, and have added new plots in within this study framework to evaluate the role of dominance and mycorrhizae in modulating diversity. We have also continued to quantify community responses in restoration plots seeded with either local sources of dominant grasses or cultivars of the dominant grasses (selected for high productivity, seed output, and germination rate) that were established in 2006 at Konza Prairie and additional non-LTER field site in Illinois. In addition to testing the hierarchical consequences of intraspecific variation on community assembly and recovery of ecosystem processes, the replicated experiment across a precipitation gradient containing nested treatments of seeded species diversity aims to generalize patterns across multiple species pools and over a broad geographic region. In 2010, we initiated the Restoration Chronosequence Experiment. The study design includes restoration of replicated 20 m x 20 m plots in an agricultural field every other year for the first 6 years (to address short-term objectives) and continued until the establishment of 24 field plots according to a decadal plan. The long-term objective of this initiative is to establish a restoration chronosequence to quantify changes in physical conditions, organism abundances, and ecosystem processes using space-for-time substitution. A short-term objective is to evaluate the potential role of variability in environmental conditions (climate associated) on community assembly. Seed was collected from Konza Prairie and nearby locations in Riley Co., Kansas during summer and fall of 2009. Seed for each species collected was analyzed for germination, dormancy, and purity according to Association of Official Seed Analysts (AOSA) standards to develop seed mixes with a known quantity of live seeds. Seed will be collected every 2-3 years and analyzed according to the same methods to maintain consistent species and seeding rates over time. In late May of 2010, the first four chronosequence plots were seeded into a lightly disked agricultural field by hand at a seeding rate of 10 lbs live seed/acre (1.84 kg live seed/ha) using a total grass:forb live seed ratio of 40:60. Species composition will be measured in late summer of 2010 and every following spring and late summer.

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 CO₂ concentration, N deposition, habitat fragmentation, etc.). We have been assessing the causes and consequences of this ecosystem conversion from C4 grass to C3 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 C4 grassland to closed-canopy C3 shrub/woodland. In 2009, Briggs presented a summary of Konza LTER woody plant expansion results at a Global Change conference at Penn State University.

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.

LTER investigator Wisely is continuing her studies on the effects of woody encroachment on disease ecology with emphasis on the rabies virus. Two manuscripts based on this work are currently in review. Wisley's lab is also working with KSU College of Veterinary Medicine and Kansas Dept of Health and Environment to create a regional zoonotic disease database that includes both human and animal cases.

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 2008-10, 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.

We are also assessing the effects of fire and grazing management on dipteran parasites of grasshoppers. Grasshoppers are host to a number of parasites and parasitoids, but the dynamics of infection are poorly understood. We conducted a 3 year survey of parasitism rates of 9 grasshopper species at Konza Prairie to measure how prescribed burning and grazing management affects rates of infectivity and grasshopper fecundity from nemestrinid and tachinid flies (Diptera). Parasitoid infections were 3x more abundant in bison-grazed watersheds than ungrazed ones although significant differences in host susceptibility were observed (0.01-20% infection rates among species). Parasitoid infection reduced individual grasshopper fecundity ~40-100%, depending on host species. Habitat characteristics (grasshopper density, vegetation biomass, and vegetation quality; measured in 2008 and 2009) had some effects on fecundity, but these were not consistent over time or among species. Fecundity increased throughout the summer, indicating that grasshoppers were able to acquire sufficient nutritional resources for egg production in the early fall when vegetation quality is generally low.

Linking the ecology of migratory birds in the native grasslands of North and South America

Sandercock conducted demographic research of Upland Sandpipers at breeding sites at Konza Prairie in Kansas and at nonbreeding sites west of Tacuarembó, Uruguay. The international work was made possible by a \$20K international supplement to the Konza Prairie LTER V. In 2009, we completed an 8-week resighting effort that will be the final year in a 9-year mark-recapture study at Konza Prairie. In the winter of 2009-10, Sandercock and international collaborator Matilde Alfaro completed a 12-week study in Uruguay examining the seasonal survival and space use of nonbreeding sandpipers. The field season in Uruguay was the second winter of field work and our international team successfully located new flocks of nonbreeding birds, and captured and deployed radios on 20 birds. To date, we have had no mortalities among the 40 birds monitored at nonbreeding sites. Combining these data with seasonal and annual estimates of survival suggests that migration is the most risky period for migratory sandpipers. This is one of the first studies to combine seasonal and annual estimates of survival. Our results provide important insights into the development and maintenance of migratory behavior, and will aid in conservation of migratory birds.

Fungal Communities in Riparian Gallery Forests and in Urban Green Oases

We continue research led by LTER scientist Dr. Ari Jumpponen to investigate the phyllosphere and rhizosphere fungus species richness in urban/suburban green oases (including arboreal trees in parks and on campuses). This program broadly targets the symbiotic fungi that colonize and inhabit trees in genus *Quercus* (oaks) in native riparian gallery forests and in human-made stands. Konza Prairie LTER serves as a location for two endemic riparian forests – the watersheds of Kings and Shane creeks. The initial findings across the phyllosphere and rhizosphere fungal communities indicate that native stands maintain higher species richness, higher diversity and are functionally more diverse than the urban stands. This research is currently aiming to identify the mechanisms that lead to the community differences among the land use types. Among the competing hypotheses are: isolation by distance (as indicated by lower propagule loads) and environmental selection of tolerant genotypes (as indicated by greater heavy metal tolerances). The findings will contribute to better understanding of diversity, species richness and community function in native and urban environments as well as anthropogenic factors in contemporary evolution. Targeting urban stands also provides a convenient avenue for outreach activities. 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 new undergraduate (including one REU) and graduate students (including a new GAANN student) into the new components of this research.

Grassland Stream Studies.

Grassland stream studies continue to be 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 three permanent sites is ongoing. In 2009-10, Dodds and his students continued 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 2009-2010, we continued long-term monitoring of stream discharge, chemistry, macro-invertebrates and fishes. In 2010, we also initiated new monitoring of stream geomorphology and sediment transport, being led by a new collaborator in the 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. We also initiated new mesocosm experiments on interactions between nutrient loading and consumer communities in tallgrass streams under non-equilibrium conditions of flood and drying.

We initiated two new experiments in 2009-2010. Dodds, Gido and Whiles initiated a new 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. Through this effort, they are examining potential responses of 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 that will begin next year and to bison grazed catchments on Konza. 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 there is little data on how it may impact headwater streams. We also began baseline sampling for the patch-burn experiment in the Shane Creek watershed at the Konza LTER site. We found that ecosystem characteristics are similar across these two sites. Both sites will be subject to similar grazing and rotational burning regimes, starting in Spring 2011, and we will continue to assess the impacts of these patch-burning grazing treatments on stream ecosystems and communities.

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. We started sampling sediments for a more extensive (entire watershed) removal in two years. In summer 2010, we also completed baseline sampling for the whole-watershed woody riparian removal experiment on watershed N02B, with vegetation removal to be initiated winter 2010. 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 will reduce stream water flow (as a result of increased transpiration), reduce grasses that retain sediments, and subsidize the stream channels with nutrient-poor/ carbon-rich leaves, leading to greater nutrient retention. We predict that woody invasion will alter 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 will

mechanically remove 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 also plan to take advantage of this removal to sample 1) stream invertebrates, 2) riparian invertebrates, 3) riparian vegetation, and 4) riparian soil fungi. We will also initiate a riparian restoration comparison by re-seeding smaller areas of the removal.

LTERR 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 2010 represent the 14th year of collections from Kings Creek. In addition, we completed the first 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 2010, graduate student Erika Martin continued studies of inter- and intra-specific interactions among prairie stream fish species in Kings Creek. A 15 year dataset on Kings Creek fish species is being used to assess temporal and spatial variation in species abundances with environmental changes. This project also uses the Konza LTER experimental stream units to conduct studies on dominance hierarchies and environmental consequences of varying fish communities. This fall will be the first of four bi-annual comprehensive surveys of Kings Creek fish populations where the stream will be sampled from the bottom of Konza Prairie every 100 meters to the headwater reaches

Groundwater Hydrology and Geochemistry

In addition our surface stream studies, we continue to monitor groundwater discharge and nutrient chemistry 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. In addition, two wells are being monitored for a new M.S. student's thesis research, focused on soil- and groundwater chemistry and gases, dissolved species and stable isotopes, before and immediately after major rainfall events. Beginning in May, 2009, an additional method for collecting and directly measuring the CO₂ in groundwater was begun: downhole gas samplers. In connection with that research, the soil lysimeters near the wells have been refurbished or replaced, and soil-gas tubes installed. This permits collection of soil water, soil gas from the same depth as the soil water, and groundwater. In addition, pressure transducers are monitoring water levels constantly in one of the two wells; the third transducer is installed in a sealed lysimeter that no longer holds vacuum, so that it is in direct contact with the soil atmosphere. This pressure transducer will record soil air-pressure fluctuations, and these will be compared to barometric pressure, also being monitored on the same frequency. Mr. Michael Robbins, Ph.D. candidate, is also in the research and design phases for a soil-gas monitoring system planned to be located, in part, in the N04D watershed at Konza. He is designing.

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 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. We used the coupled model to simulate the cycling and transport of water, carbon and

nitrogen within the 11 km² 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, 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 the next year we will link GTHM-PSM with ENVISION, a decision support framework developed by Oregon State University (<http://envision.bioe.orst.edu/>). 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 km² 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 air quality modeling component of this work is being conducted under separately funded projects by Kansas State University and EPA Region 7.

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. 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. 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. Several sites, including KNZ, are compiling additional maps covering additional dates and conducting interviews with local residents this summer as a complement to their current map analyses. At the Konza LTER site, activities in 2010 include interviews with local stakeholders (residents, land-owners, ranchers, land-stewards, etc.) to obtain a deeper and richer understanding of local ecological knowledge. With support from this supplement, the KNZ will also conduct digital image processing of regional satellite imagery from one additional date to provide another time step for the maps analysis. We will advance our statistical analysis of the maps through another graduate level seminar at Clark University in which the focus will be on creating metrics for cross-site analysis.

20th Annual Konza Prairie LTER Investigator's Workshop.

The Konza Prairie LTER program hosted its 20th annual LTER Workshop on April 10, 2010, 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 2010 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. It also included visiting scientists from the Chinese Academy of Sciences and Northeast Normal University. The scientific program included a full day of oral presentations by graduate students and senior scientists, as well as poster presentations. 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.

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*”. 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.

Information Management.

Information management continues to be an essential component of the Konza Prairie LTER program. Adam Skibbe and Carol Gadbury, Information Manager and Archivist respectively, were joined by Tammy Sonnentag as a new part time student data enterer (replacing graduate Samantha Miles). We have added three additional part time student workers, Caleb Siebel (data enterer), Rahul Choubey (programmer) and Courtney Estes (geographic information systems), to assist in information management activities.

In 2010 we have continued to work towards our existing long-term goals as well as enhancing several focal areas of the Konza LTER IMS. As with previous years, we rely on the Internet as our primary outlet for sharing information and data related to the Konza Prairie LTER. A continuing 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 stress that these data continue to be made available to outside investigators without restriction. We continue to offer our data on our website (<http://www.konza.ksu.edu>) both as ASCII text files as well as via a SQL Server download with a query option. We continue to offer metadata for both 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 2010, Mr. Skibbe and Mr. Choubey have been redeveloping several components of our IMS to enhance the user experience. The focus of these efforts have been on our public web interface and development of an internal content management system (CMS) to better manage our web content. Once completed this project should result in a much more user friendly and reliable web site as well as a CMS to aid us in making prompt future updates to web content.

A continued focus of the Konza LTER IMS has been on organization and digitization of all original field data. We have moved copies of all original field data off site to ensure long-term retention. Additionally we have continued to scan every piece of field data to have and provide digital scans (.pdf) to compliment our SQL and ASCII version of the data for every available dataset. Our hope 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.

In the spring, Mr. Skibbe along with other LTER information managers completed phase one of the LTERMapS network wide online GIS mapping interface (<http://www.lternet.edu/map/>). Work on phase two of this project continues to be a focus for the upcoming year. In addition to this shared resource, we are working toward having a better online mapping presence for the Konza LTER (both applications and services) as well. In addition to online GIS resources the Konza LTER continues to work towards increasing our spatial data offerings, both in historic data as well as adding newly collected data with special emphasis on offering a complete series of burn history data as well as other research 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 fall 2009 we purchased two additional blade servers to finalize phasing out our older rack units. These run a series of virtualized servers and with the iSCSI SAN allow us to have fail over between all of our virtualized machines and ensure stability in our IMS. Additionally, we expanded our storage from 900 GB to 5 TB in order to keep up with our growing data requirements.

In 2010 we have focused on updating a variety of our metadata and procedural protocols to ensure any changes in technique on our datasets are accounted for. Specifically we are in the process editing our data catalog (meta data), our methods manual (techniques), as well as our data entry procedural handbook. In addition to this we have established a better workflow for the data process (from field data through entry, and QA/QC) to provide a better system for prompt entry and updates to data.

We will continue to expand our metadata and its availability to Metacat. For example, users will not only be able to query publications through key words, but also by datasets used or related datasets. We will also work with other LTER IMs to create a project database to better manage our site projects (a planned network-level IM activity). We also plan to create 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, and 1 post-doctoral associates. 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 2008-10: Colorado State University (Greg Buis, Amanda Lease, David Hoover), Cornell University (Rebecca Lohnes), Southern Illinois University (Ryan Klopf, Dan Whiting), Yale University (Cynthia Chang, Meghan Avolio, Kimberly Kamatsu), University of Kansas (Lisa Tiemann), 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 2008, we supported 2 local REU students with a supplement to our core LTER grant and an additional 8 students through a site-based REU program centered around the Konza Prairie Biological Station (<http://www.k-state.edu/bsanderc/reu/>). Although REU supplements were not provided in 2009, we were able to support several REU students working on Konza in both 2009 and 2010 through the KSU REU site grant. This is the 15th year that a REU site program has been offered by the Division of Biology and Konza Prairie Biological Station, and in 2010 the site-based REU program supported 7 students, with another 9 students participating with support from individual grant supplements of University support (McNair Scholar's program and SUROP). For a list of current and recent REU student projects, see www.k-state.edu/bsanderc/reu/. The Konza Prairie LTER program has a strong history of providing research experiences for students from under-represented groups, which we will 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 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.

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 has been used by a number of SLTER classes now. 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. Blair, Knapp and Smith have been regular participants in LTER planning for the future (the ISSE initiative). 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). A new initiative to link ecological and health-related disciplines to address the ecology of diseases is being spearheaded by Konza scientist Samantha Wisely.

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 collaborative studies being done at the Konza Prairie LTER site include:

- 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)

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, Pietermaritzburg)]. 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 Averages-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 Koppelaar, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, South Africa).

Konza-Related Extramural Grants (not including LTER funding) active during the current reporting period (2009-2010)

Baer, S.G. and D.J. Gibson. 2005-2009. Hierarchical consequences of intraspecific variation on community and ecosystem re-assembly. NSF Ecology Program, \$445,000 (Southern Illinois University).

Blair, J.M. and A.K. Knapp. 2007-2010. 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. 2005-2009. Collaborative Research: LTREB long-term ecosystem responses to more extreme precipitation patterns and warming. NSF LTREB Program, \$300,000.

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., J.M. Blair, and J. Harrington. 2006-2009. Understanding and forecasting ecological change: Causes, trajectories and consequences of environmental change in the Central Plains. NSF EPSCoR Program, \$3,263,478 (KSU portion).

Ferguson, C. J., and M. H. Mayfield. 2006-2009. Computerization of the Kansas State University Herbarium: digitizing a critical biodiversity collection for the Great Plains. NSF Biological Research Collections, \$383,674.

Hartnett, D.C. 2006-2009. Building renovation for new meeting facility at Konza Prairie Biological Station. NSF Field Stations, \$300,000.

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., 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. Ecology, evolution, and genomics in changing environments. 2009-2012. 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.

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 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).

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.

Wilson, G.W.T., and B.K. Sandercock. 2006-2009. NSF Research Experience for Undergraduates: Ecology and evolutionary biology of grasslands. NSF REU Site Program, \$200,000.

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

Wisely, S.M., B. K. Sandercock, and others. 2010. Development of regional planning tools to assess the impacts of climate and land use change on a sensitive grassland bird. U.S. Fish and Wildlife Service, \$47,349.

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.