Annual Report for Period: 11/2008 - 10/2009
Submitted on: 07/21/2009
Principal Investigator: Blair, John M.
Award ID: 0823341
Organization: Kansas State University
Submitted By:
Blair, John - Principal Investigator
Title:
Konza Prairie LTER VI: Grassland Dynamics and Long-Term Trajectories of Change

Project Participants

Senior Personnel

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

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

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

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

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

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

Contribution to Project:

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

Name: Johnson, Loretta

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Briggs, John

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Gido, Keith

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Goodin, Douglas

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Koelliker, James

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Macpherson, Gwendolyn

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: McKane, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

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

spatially-distributed (GIS) framework.

Name: Rice, Charles

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Sandercock, Brett

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Collins, Scott

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Ferguson, Carolyn

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Garrett, Karen

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Jumponnen, Ari

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Kaufman, Glennis

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Price, Kevin

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Whiles, Matt

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Zolnerowich, Gregory

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Kaufman, Donald

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Wisely, Samantha

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Baer, Sara

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Harrington, John

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: McLauchlan, Kendra

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Craine, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Fay, Philip

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Horne, Eva

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Wilson, Gail

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Smith, Melinda

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Olson, K

Worked for more than 160 Hours: Yes

Contribution to Project:

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

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.

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.

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

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, Jacquiline

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Parsons, Sheena

Worked for more than 160 Hours: Yes

Contribution to Project:

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

Name: Reisinger, Alex

Worked for more than 160 Hours: Yes

Contribution to Project:

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

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.

Undergraduate Student

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Name: Miles, Samantha

Worked for more than 160 Hours: Yes
Contribution to Project:
data entry

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

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

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

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

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

Technician, Programmer

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

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

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

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

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

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

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.

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 Program for Ecosystem Research (PER) is supporting research being done 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). 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 has provided 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) is conducting research at Konza Prairie to address 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 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 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. The Konza LTER program provides a subcontract to Yale University and logistical support for these studies. Several other KNZ 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 programs provides a subcontract to Oklahoma State University to support collaborative research with Dr. Gail Wilson.

Averaves - Investigaci¾n y Conservaci¾n

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.

Other Collaborators or Contacts

The Konza Prairie LTER program serves as a research platform for collaborative research involving numerous scientists from KSU and from other institutions. The infrastructure, long-term experiments and databases provided 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. In 2006-08, we greatly 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 three 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:

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

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

- studies of prokaryotic community composition and responses to disturbance, directed by Barny Whitman (UGA);

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

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

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

Konza LTER scientists are also involved in a variety of international collaborative efforts. For example, Konza LTER scientists and scientists from South Africa are conducting collaborative studies of ecological responses to fire and grazing in North American and Southern African grasslands [J. Blair (KSU), M. Smith (Yale), Alan Knapp (CSU), Scott Collins (UNM) and collaborators in South Africa (Kevin Kirkman and Richard Fynn at the University of KwaZulu-Natal, Pietermarizburg)]. Konza co-PI David Hartnett maintains collaborations with colleagues in Botswana, and has supported exchanges of graduate students there. In 2008, Hartnett re-visited field sites in Botswana with another LTER scientist (Gail Wilson) and LTER graduate student Jacqueline Ott to conduct research on bud bank ecology and the regulation of dynamics of southern African grasslands. In addition, Hartnett and Joern are Co-Directors of the Institute for Grassland Studies at KSU, which promotes international collaborative research on grassland ecology, and in 2009 Hartnett led a field class on a trip to South Africa and Botswana. In 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.

Konza Prairie continues to host numerous visits by international scientists and students, including (in 2008-09): Dr. Marjan Jongen of the Instituto Superior de Agronomia, Lisbon, Portugal; Matilde Alfaro-Barrios of Averaves-Investigaci¾n y Conservaci¾n, 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 Koppenaal, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, 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 and developing scientists 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 students and teachers to work with, and learn from, Konza LTER scientists. Finally, a newly funded GK-12 project (led by Konza LTER co-investigator Caroyn Ferguson) is providing opportunities for two Konza LTER graduate students to work with local high school teachers to enhance science education and communication.

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 SLTER program is supported with supplemental funding from the NSF LTER program, and private foundations and local businesses. The Konza Prairie SLTER is a unique science education program built around the successful Konza Prairie LTER program and targeting K-12 teachers and their students. This program is directed by the Konza Prairie Education Coordinator (Dr. Valerie Wright) with input from the Konza Prairie LTER PIs and local K-12 educators, and the assistance of a cadre of trained docents that participate in on-site SLTER activities with classes from local school districts. These hands-on activities were originally designed with input from researchers and local elementary, middle and high school teachers to give students an appreciation of the activities of LTER scientists and to provide them the opportunity to collect their own data. 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.

The Konza Prairie SLTER program educates students about the scientific process, and grassland ecology in particular, by engaging students and teachers in realistic and relevant science-based activities focused on long-term data collection at our LTER site. These activities are designed to give students an understanding of ecological research and the activities of LTER scientists, and to provide them the opportunity to collect and interpret their own data. As an example of recent novel activities by the Konza SLTER program, a high school teacher and her students carried out a special floristic survey of Wabaunsee County, KS, looking at changes in diversity since early surveys done by Maus in 1927.

Until 2004, the Konza Environmental Education Program (KEEP), and associated SLTER program, focused primarily on teachers and their students in the United School Districts closest to the Konza Prairie Biological Station, and utilized the Konza Prairie LTER site for field-based activities. As SLTER activities at the Konza Prairie have approached maximum capacity and utilization for the site, we sought and were awarded additional funding (EdEn 2004) to expand our current program to reach teachers outside our local area. Most of these teachers come from districts with a high percentage of rural families (many also economically disadvantaged) and with limited access to good local or regional science resources. The 'regionalization' of the Konza Prairie SLTER program is the most appropriate way to expand our successful program to reach teachers and students in more distant and rural portions of Kansas. With EdEn support (2005 and 2006) and enhanced SLTER support (2007 and 2008), we developed and offered intensive summer workshops for non-local teachers. These 'Prairies Across Kansas' workshops are designed to assist teachers with incorporating region-specific grassland studies into their science curricula, and developing designated native prairie sites near their home schools (Satellite SLTER sites) for field-based science education activities. Class data and Konza Prairie SLTER long-term databases are accessible on the Internet and can be manipulated in the classroom to give students an understanding of the scientific process. With the Prairies Across Kansas program, students are able to compare their unique prairie ecosystems to the tallgrass prairie of our core LTER site.

To date, the Konza SLTER program has trained 64 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 2008, 1160 students from 20 schools experienced 45 hands-on activities at Konza Prairie. The Prairies Across Kansas program impacted an additional 430 students across the state for a total of 1590 students. These hands-on activities were designed with input from researchers and local elementary, middle and high school teachers. 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 > 8000 students from third grade through high school with SLTER activities at Konza Prairie and another 1750 across the state through PAK. In 2009, 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. Also in 2009, Valerie Wright (Konza Environmental Education Coordinator) was invited to participate in the National Phenological Network meeting in Arlington, VA (June

17-18, 2009), and assist with evaluating the education components of that program.

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. In 2009, two Konza LTER students (Dan Carter and Jacob Carter) were selected to participate in the GK-12 program, and both will incorporate LTER science 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 dominate the curriculum. The Konza Prairie LTER program has a strong record of providing training opportunities for undergraduates via employment of research assistants (approximately 25 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 14th year that a REU site program has been offered by the Division of Biology and Konza Prairie Biological Station, and in 2009 the program supported 11 students. For a list of current and recent REU student projects, see www.konza.ksu.edu/general/reu.html. Also, 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 new (2008) '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 two educational publications, based on LTER data, for the peer-reviewed ESA-supported Teaching Issues and Experiments in Ecology (TIEE) web site:

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

The Konza LTER program provides 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), 57 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 (2008-2014):

2009

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

2008

Casey, A.E. 2008. Fine-scale genetic structure and extra-pair parentage in the socially monogamous Upland Sandpiper. M.S. thesis, Kansas State University. Manhattan, KS. 56 pp

Coolon, J. 2008. Ecological genomics of nematode responses to different bacterial environments. Ph.D., Kansas State University. Manhattan, KS.

Heisler, J. L 2008. Sensitivity of grassland ecosystems across the Great Plains to present and future variability. PhD Dissertation, Colorado State University. Fort Collins, CO. 161 pp

Hoover, D. 2008. Altered rainfall due to climate change: Modeling the ecological effects on grasslands . MS Thesis, University of Connecticut. Storrs,CT. 63 pp

Mandyam, K.G. 2008. Dark spetate fungal endophytes from a tallgrass prairie and their continuum of interactions with host plants. PhD Dissertation, Kansas State University. Manhattan, KS. 136 pp

Nepal, M.P. 2008. Systematics and reproductive biology of Morus L. (Moraceae). Ph.D., Kansas State University. Manhattan, KS.

Schmitt McCain, K.N. 2008. Limitations to plant diversity and productivity in tallgrass prairie. PhD Dissertation, Kansas State University. Manhattan, KS. 137 pp

Strum, K.M. 2008. Exposure of migratory shorebirds to organophosphorus and carbamate pesticides at migratory stopover and non-breeding sites in the western hemisphere. M.S. thesis , Kansas State University. Manhattan, KS. 76 pp

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 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 2008-09, 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, and the Great Plains Plant Systematics Symposium. Konza LTER scientists communicate research results through regular presentations to regional farming, ranching and conservations groups including the Tallgrass Legacy Alliance 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.

At a national level, Konza scientists 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/). The importance of long-term ecological research and climate change experiments were highlighted during the interview. 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 2008-2009. 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 û 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. 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.

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Other Specific Products

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:

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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 used Konza LTER studies and data to address critical issues related to global change, including the effects of climate change (Heisler et al. 2008, Heisler et al. in press, Fay et al. 2008, Gerten et al. 2008) and land-use and land-cover change (Kitchen et al. 2009, Knapp et al. 2008, McKinley et al. 2008.

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

Finally, an important contribution of the Konza LTER program to the advancement of ecology is to provide a unique resource, in the form of the site infrastructure, long-term experiments, and available data that can be used by the general ecological community to address a wide range of ecological questions. Konza Prairie serves as a node in many national networks, including the National Atmospheric Deposition Program (NADP), the EPA Clean Air Standards and Trends Network (CASTNET), NOAA's Climate Reference Network (CERN), and the USGS Hydrologic Benchmark Network. The Konza Prairie site has also been selected as a candidate core site for the developing National Ecological Observatory Network (NEON), and Konza LTER scientists have been active participants in the NEON planning process, and in local and domain-level activities.

Konza LTER scientists continue to make significant contributions to international collaborative efforts in ecology. David Hartnett was co-convener of an NSF-sponsored US-Africa Workshop to enhance collaborative research on the environment in sub-Saharan Africa and is a participant in the 'Sekgwa Project' (U. Botswana and Okavango Research Center) to promote collaborative research and training on the ecology and dynamics of southern African grasslands and savannas. With supplemental LTER funding, Brett Sandercock is collaborating with scientists in Uruguay on a migratory bird project. Finally, several Konza PIs (Knapp, Blair, Smith, Collins) were awarded new NSF funding to extend Konza LTER studies in a test of ecological generalities in South African grasslands (Collaborative Research: Convergence and Contingencies in Grassland Savannas).

Contributions to Other Disciplines:

The Konza Prairie LTER program and our core research experiments attract numerous scientists from a broad spectrum of scientific disciplines beyond ecology. For example, Konza was used by atmospheric scientists from the University of California Berkeley (led by Rob Rhew) to assess fluxes of atmospheric methyl halides in temperate North American grassland ecosystems, employing a recently developed stable isotope tracer technique to separate simultaneous production and consumption fluxes. A hydrogeochemist from the University of Kansas (Gwen Macpherson) is a long-term collaborator in the Konza Prairie LTER program, and we support ongoing long-term studies of groundwater chemistry sampled via permanent wells located on Konza Prairie. An atmospheric scientist from the University of Kansas (Nate Brunsell) is using Konza sites to study the effects of surface heterogeneity on land atmosphere interactions, and is employing a Large Aperture Scintillometer (LAS) to measure sensible heat fluxes over longer path lengths that span Konza watersheds with ongoing C flux measurements. This allows comparison with eddy covariance stations and satellite derived estimates of surface energy fluxes. We collaborate with Gene Kelly (pedologist) and his students (Colorado State University) to assess patterns and controls of silica weathering and patterns of soil weathering and P availability in Great Plains grasslands. Another soil scientist from Cornell (Johannes Leahman) is using Konza LTER treatments to assess the impacts of landscape position and contemporary management practices on black C accumulation in soils. A hydrologist from Biological and Agricultural Engineering (James Koelliker) has been a long-time collaborator on the 'Irrigation Transect Experiment', and has provided numerous training opportunities for Biological and Agricultural Engineering and Hydrology students. Konza Prairie has also become a research platform for several collaborative teams of ecologists and molecular biologists that are part of the KSU Ecological Genomics Initiative. Many of these interdisciplinary teams are using the Konza LTER site and associated long-term experiments to address questions related to the genetic mechanisms underlying plant and animal responses to environmental constraints. The Konza LTER program has also contributed to recent research and synthesis activities in the area of Plant Pathology and Ecological Genomics.

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

Other contributions to disciplines outside the traditional realm of ecology include the operation of flux towers at the Konza site, which has provided data used by micrometeorologists, climatologists, remote sensing scientists and modelers. We also collaborate with atmospheric chemists and modelers from the EPA CASTNet program in sampling concentrations of selected airborne particles and using these to model dry deposition rates, and in 2006, two new seismographs were installed on the site to facilitate ongoing geologic research by USGS scientists and their collaborators. We also collaborate with NASA scientists in the maintenance and operation of a Cimel sun photometer at the Konza site.

Contributions to Human Resource Development:

The Konza Prairie LTER V 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. In 2008-09, for example, the site was used by graduate students from the University of Kansas, University of Colorado, University of Kentucky, University of New Mexico, Southern Illinois University, Colorado State University, Cornell University, Yale University, and several others. We also hosted field trips for students from many regional colleges and universities, such as Principia College, Concordia College, University of Minnesota-Mankato, Truman State University, Pittsburgh State University, the University of Colorado, and others.

The Konza Environmental Education program, and the Konza Prairie Schoolyard LTER Program, provide formal and informal research experiences and science education to public groups, children and K-12 teachers, as well as training experience for a graduate student in the College of Education. Konza LTER research in restoration ecology is being used by local high school teachers to develop educational activities as part of Howard Hughes funded teacher training program. In 2008-09, Blair served as consultant for a local high school teacher (Drew Ising), who is establishing a prairie restoration research site, and developing a class module on soils, for his course in Environmental Biology and

Ecology at Junction City High School. The Konza LTER program also provides research support for a GK12-sponsored graduate student working with this high school teacher. Finally, the Konza LTER site continues to be used in conjunction with the NSF-funded Girls Researching Our World (GROW) program (www.ksu.edu/grow/), with several KSU scientists and students leading educational activities for 7th and 8th grade girls.

Contributions to Resources for Research and Education:

The Konza LTER program provides a research platform for scientists and students from around the world. The Konza Prairie LTER site (Konza Prairie Biological Station; KPBS) is a 3,487-ha field research site, which includes several buildings devoted to ecological research and education. These physical resources are instrumental in attracting a large number of outside scientists to the site. KPBS facilities include the 4,650 ft.2 Hulbert Center housing a library/conference room, classroom, offices, teaching laboratory, reference herbarium and animal collections, and dormitory-style housing for 15. Two new 2-bedroom housing units expand the accommodation capacity to 25 visiting researchers. The 2,400 ft2 Ecology Laboratory houses 2 analytical laboratories, a soil and root processing lab, a computer room, and researchers' shop. In 2008, the renovation of the ground floor of a historic, 2- story limestone barn at the Konza Prairie Biological Station (KPBS) was completed. The renovated building provides support for the Konza Prairie LTER program and for visiting scientists in the form of a high-quality meeting facility and multi-use space for research, science education, and public outreach programs. Other station buildings include a fire station and shop/maintenance building, storage building for research equipment, and a residence for on-site staff. All KPBS headquarters buildings have T1 Internet connectivity, and the site has wireless data transmission capabilities.

Other LTER-related research infrastructure, includes the large 1000 ha bison research area, 98 small (25 m2) grazing exclosures, and 17 km of access roads and 61 km of fireguards separating the experimental watershed treatment units. KPBS maintains several general-purpose vehicles on-site, as well as specialized equipment (tractors, fire trucks, mowers, soil augers, etc.). The headquarters also include a meteorological station, a CIMEL Sun Photometer, and a dry-deposition monitoring facility (CASTNet). A total of 36 experimental stream units are located in the headquarters area. Other field equipment and instrumentation at the site includes three eddy flux towers for quantifying ecosystem-level C flux, four weirs and associated stream gauging equipment, 46 wells for monitoring groundwater levels and chemistry, numerous TDR probes and neutron access tubes for soil water measurements.

Additional LTER-supported laboratory facilities are located on the KSU campus, approximately 15 km from KPBS. The majority of LTER laboratory space and analytical equipment are located in Bushnell Hall (Biology), including space and equipment for preparing plant, soil and water samples for analysis (drying ovens, grinders, shaker tables, block digestors, vacuum filtration systems). Two walk-in controlled environment chambers (Conviron PGV 36) are located in Bushnell Hall. Bushnell Hall also houses an extensive collection of prairie plant specimens in the KSU Herbarium. Some specific equipment and facilities are located within other Departments (Agronomy, Biological and Agricultural Engineering, Plant Pathology, Geography), reflecting the interdisciplinary nature of our research. Some major analytical equipment available for LTER research includes: 2 Alpkem autoanalyzers (FlowSolution and RFA500) for liquid samples, a Carlo-Erba 1500 automated C/N analyzer for solid samples, a Shimadzu TOC 500 analyzer for dissolved C, a Hitachi UV2000 automated dual-beam spectrophotometer, several gas chromatographs with electron capture, flame ionization and thermal conductivity detectors, a Nikon compound microscope with epifluoresence and video imaging capabilities, 1 LiCor 6400 and 3 LiCor 6200 Portable Photosynthetic Systems (1/4 and 1 L cuvettes), a LiCor 6200 system dedicated for soil CO2 flux measurements, a LiCor 1600 null-balance porometer for stomatal conductance, and 3 pressure chambers (PMS model 1000) for measuring plant water status, 4 Tektronix cable testers (model 1502B) coupled to Campbell CR10 data loggers for TDR soil moisture measurements, a Troxler (model 3221) neutron probe gauge for soil moisture determinations, and a back-pack mounted minirhizotron (Bartz Technology Co. BTC-2) camera system. We also have access to a shared Hewlett Packard HPLC and GC/MS system for characterizing soluble organic compounds. Cold storage facilities for holding samples are available, as are sample preparation rooms for drying and grinding plant and soil samples. Climate controlled greenhouse space is available on the KSU campus. In addition, other 'typical' laboratory equipment (balances, microscopes, etc.) is available in individual investigator laboratories.

Contributions Beyond Science and Engineering:

The Konza Prairie LTER program contributes to increased public awareness of ecological and environmental issues (e.g., biodiversity conservation, habitat loss, ecosystem services, restoration ecology, etc.) through outreach and public education activities, such as the Konza Prairie biennial Visitors' Day and our docent-led public education programs. Konza LTER scientists also conduct an annual fire-training course for researchers and local land managers (35-40 participants/year). In addition, the Konza LTER Program is increasingly called upon to provide data relevant to resource management and regulatory policy. At a local level, Konza scientists participate in Kansas Agricultural Experiment Station public education events by providing information on the ecological consequences of various grassland management practices (e.g., fire frequency and grazing). At the regional level, Konza Prairie scientists are advising EPA Region 7 staff and scientists on the ecological benefits of fire in maintaining native tallgrass prairie habitat and diversity, including several meeting with both regional and national EPA officials. This issue has become very important, as the potential impacts of grassland burning on regional air quality have been receiving increasing scrutiny. Konza scientists also participated in the development of a management and monitoring plan for the Tallgrass Prairie National Preserve, and a training workshop in tallgrass prairie ecology and management for the NPS Rangers at the National Preserve. In 2008, Konza Prairie hosted a field trip for scientists from the Natural Resources Conservation Service. Konza LTER scientists also serve on

the planning committee for the Flint Hills Regional Interpretive Center. At a national level, Konza Prairie hosted a delegation of 15 U.S. Congressional Assistants, which highlighted results from the Konza LTER program as an example of the value of long-term ecological studies for the long-term sustainable management of natural resources. Konza scientists have also served as advisors for a Smithsonian Museum of Natural History exhibit on grasslands and agriculture (Forces of Change), as well as a traveling museum exhibit (Listening to the Prairie). In 2008, Konza Prairie was the focus of a photographic exhibit at the Department of Interior Museum in Washington, D.C. In the international arena, Konza Scientists have provided information on grassland management to scientists and park resource managers from South Africa, Australia, and Hungary, with many of these visits focusing on resource management issues of public concern. The Konza Prairie LTER database is also being used to address issues relevant to regulatory policy. Long-term data on Konza Prairie streamwater quality is providing a baseline for regional water quality in the absence of agricultural practices or other disturbances. LTER data on soil chemistry is also being incorporated into ongoing studies to evaluate the potential of grassland management practices to increase soil C sequestration to offset atmospheric CO2 loading.

Finally, the Konza Prairie LTER site, and the unique watershed fire and grazing treatments, have been the focus of several art-related activities. For example, local artist Edward Sturr produces limited edition hand-colored photographs and lithographs of Konza landscapes (www.prairielight.com), and a photographic exhibit of Konza Prairie by nature photographer Judd Patterson (www.juddpatterson.com)was featured at a recent exhibit (A Sea of Tallgrass: the Konza Prairie) at the Department of Interior in Washington, DC.

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 Web/Internet Site
Any Product
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 2008-09 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. in review*). 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. in press*) 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. With 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.

Bud Banks and Plant Population Responses to Nitrogen Enrichment.

A recent Konza LTER study (Dalgleish *et al.* 2008) utilized a long-term N addition experiment (The Belowground Plot Study) to parameterize matrix population models of the effects of nitrogen availability on bud bank dynamics of two tallgrass prairie grass species. Nitrogen significantly and differentially influenced release of bud dormancy, tiller emergence, and tiller population growth rates (λ) in the two species, but had no effect on the growth rate or size of individual tillers. These matrix model analyses and an additional field study on Konza (Dalgleish and Hartnett 2009) demonstrated that 1) bud bank dynamics were the most important demographic process driving grass population responses to resource availability, 2) variation in the productivity of tallgrass prairie grasses is driven primarily by the demography of bud and tiller populations rather than by the physiology and growth of individual tillers, 3) vegetation responses to disturbances (fire and grazing) are strongly mediated through effects on bud bank dynamics, and 4) the size of the grassland bud bank is an excellent predictor of both long-term and short-term variation in ANPP. These findings will lead to improved predictive models of grassland responses to environmental change.

Development of a Plant Trait Database for Konza Prairie.

In 2008-09, Craine and Nippert also initiated collection of new data for an extensive plant trait database for the herbaceous Konza flora. For this study, 125 species are being grown under controlled conditions and traits that relate to the water, nitrogen, and carbon economy of species are being measured. Konza prairie contains over 550 vascular plant species, although detailed ecophysiological trait characterizations are available for only a few species. Such information 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. Understanding which traits are the best predictors of relative abundance along a continuum of water availability (well watered to water stressed) will aid in the prediction of plant community structure under altered temperature-precipitation regimes. In this research, both anatomical and physiological measurements were taken on 125 species of herbaceous tallgrass prairie plants grown from seed in a growth chamber. Gas exchange measurements including transpiration rate, photosynthetic rate, stomatal conductance to vapor, and intercellular CO_2 concentration were taken under optimal light, temperature, and humidity conditions. All plants were exposed to a dry-down period and were monitored until conductance fell to zero. At this point, water potential (Ψ_{crit}) was measured and the plants were harvested to measure root length, diameter, volume, and mass, leaf area, leaf tissue density, root tissue density, and root to shoot ratio Traits were compared using pair-wise bivariate analyses and principal component analyses (PCA). Clear differences were detected between grass and forb functional groups and a clumped dispersion pattern was seen in the PCA. The rotated factor pattern suggested a dichotomy between dry-adapted plants with thin, dense leaves and roots, highly negative Ψ_{crit}, and large plant size and hydrophiles which have the opposite profile. A second axis offers more separation based on high photosynthetic rate, high conductance rate, and leaf posture, but fails to provide a distinction between C_3 and C_4 species. Using the LTER datasets from Konza Prairie, these traits will be compared to relative abundance data to detect key determinant traits or suites of traits. Future work will incorporate stomatal characteristics including density and abaxial/adaxial ratios as well as investigate the role of landscape heterogeneity as determinants of these characteristics. These data are also being complemented in 2009 with traits from field-grown plants, with over 100 species already collected at first flowering. The database of plant traits will be useful for explaining patterns of plant species abundance across the Konza landscape, as well as responses to climatic variability and multiple experimental manipulations.

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. in press). 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).

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. Nippert and Knapp (2007a, b) measured differences in water availability, plant water stress, and source of water used by C4 grasses and C3 forbs and shrubs to demonstrate that co-occurring species differ in patterns of water-use, and some species alter water-use based on climate and site-specific environmental variability. Across a regional gradient from tallgrass prairie to desert grasslands, Dalgleish and Hartnett (2006) found a strong positive correlation between bud bank densities and interannual variation in annual net primary productivity (ANPP). Lower variability in ANPP in more arid grasslands can result from meristem limitation, constraining the capacity of these grasslands to respond to current or future climate variability (Dalgleish and Hartnett 2006). In a separate study, patterns of culm production over 25 years were analyzed for three dominant perennial tallgrass prairie species (*Andropogon gerardii, Sorghastrum nutans*, and *Schizachyrium scoparium*) in an annually burned watershed at Konza (Craine et al. in review). Culm production of all three species increased with higher growing-season soil moisture and precipitation, but differed in their responses to water availability at different times during the growing season. Relative to Andropogon, Sorghastrum responded more to precipitation early in the growing season and Schizachyrium to soil moisture late in the growing season. Flowering culm production averaged just 8% of total graminoid aboveground net primary production, suggesting the majority of interannual variation in the ANPP of grasses comes as a result of differences in leaf, not stem, production.

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

Continued field studies of longitudinal patterns of productivity and diversity in Konza Prairie streams indicated that these systems are more heterotrophic than we originally hypothesized; reach-scale metabolism estimates revealed that even open, headwater channels were only net autotrophic during a few summer sampling dates, and were net heterotrophic most of the year. Although primary production was often higher in open, headwater reaches, respiration was also high (and thus P/R was often ~1 or <1) and appears to be linked to large ingrowths of roots into the stream from riparian vegetation; roots accounted for ~48% of the annual average coarse particulate organic matter standing stock in the uppermost headwater site of the gradient we examined. Secondary production estimates from this study are significantly higher than prior estimates from some of the same stream reaches (Stagliano and Whiles 2002) underscoring the inherent temporal variability of these systems. This study has produced estimates of metabolism, primary and secondary production, and energy flow pathways along a continuum from grassy headwaters to gallery forest stream reaches; a thesis and manuscript detailing findings are currently in preparation. Experimental streams were also used to evaluate the effects of grazer identity and temperature on ecosystem processes. Bengtson et al. (2008) found that grazing minnows had a strong negative effect on benthic communities during the fall, when water temperatures were low, whereas crayfish effects were negligible. In summer, when temperatures were high, the two taxa had similar effects on ecosystem properties.

Consumers are increasingly being recognized as important drivers of ecological succession, yet it is still hard to predict the nature and direction of consumer effects in non-equilibrium environments. We used stream consumer exclosures and large outdoor mesocosms to study the impact of macroconsumers (i.e. fish and crayfish) on recovery of intermittent prairie streams after flooding (Bertrand et al. 2009) and drying (Murdock et al., in press). Macroconsumers altered system recovery trajectories by altering algal and macroinvertebrate biomass, primary productivity, and benthic nutrient uptake rates. These effects were generally greatest within the first few weeks following disturbance. However, in addition to this transient macroconsumer influence, ecosystem effects were dependent on disturbance type and some effects were reversed with time since the disturbance. Following floods, two dominant consumers (a grazing minnow *Phoxinus erythrogaster* and a water-column minnow *Cyprinella lutrensis*) generally stimulated recovery of stream periphyton communities after flood, but grazing minnows delayed recovery of benthic communities following stream drying. Contrasting results from these experiments were attributed to differential rates of colonization by consumer species, which in part was a function of the type of disturbance. These studies highlight the importance of consumer impacts in regulating succession of non-equilibrium systems. However, the consumer effects are likely to be dependent on the disturbance regime and diversity of the consumer community.

After 1 year of sampling 4 sites on Fox Creek that a similar physical characteristics (e.g., size and position in the watershed) as LTER sites on Konza, we were able to document intraannual variability in the fish communities in both Fox Creek and Kings Creek. Fox Creek has a more species rich fauna than on Konza and at least in the first year of sampling, fish community structure in both locations remained relatively stable. However, 2009 was a wet year, and continued monitoring will allow us to contrast those dynamics and comparisons among years with variable climatic conditions.

Konza Prairie Groundwater Studies.

Based on LTER records, Macpherson et al. (2008) documented a dramatic increase (20% over 15 years) in CO_2 in the groundwater at the Konza; this article was featured on Discovery.com news, and

was the 6th most frequently downloaded article for November and December in Geochimica et Cosmochimica Acta. This research used an ongoing long-term database of groundwater hydrology and chemistry. An expansion of this work is in progress, with more detailed calculations of the apparent increase in chemical weathering rates at the Konza site.

One of Macpherson's (KU) undergraduate students completed a research project contrasting summer and late-fall stream water, quantifying the CO_2 loss from about 400 m of the lower portion of the N04d stream. This project involved designing, calibrating and using a pitot tube to measure water velocities in very shallow streambeds and in stretches of very slow-moving water, where traditional flow meters cannot be used. The findings of the project include initial assessment of the losing portions of the stream, and that C emissions from this stream are on the same order of magnitude as C emissions documented from other streams (e.g., Worrall and Lancaster, 2005). This project was funded, in part, from the competitive AWG-Osage Chapter Undergraduate Research Award, 2008, to Karen Ohmes, University of Kansas.

Another of Macpherson's undergraduate students is working on a research project which will be a KU Honor's Thesis. This project revisits two of the water wells where chemistry was measured only during the early 1990's. These wells are still in open prairie; the wells that are part of the longest-term groundwater chemistry study at the Konza are very nearly surrounded by woody vegetation. Measurements will continue for a year, and be used to compare the groundwater CO_2 and other parameters from 2008-9 to the earlier data, to test whether the invasion of woody vegetation is the cause of the increasing groundwater CO_2. This project is being funded, in part, from the competitive AWG-Osage Chapter Undergraduate Research Award, 2009, to Breanna Huff, University of Kansas.

In June, 2009, Macpherson (2009) published a manuscript (1) showing the general distribution of CO_2 in groundwater and (2) constraining the world-wide annual CO_2 release to the atmosphere when that groundwater is pumped from the ground, using Konza data as one of the extreme water-chemistry types.

Mycorrhizal Ecology.

Previous Konza Prairie studies have shown that the mutualistic symbioses between plants and mycorrhizal fungi have large effects on plant population dynamics, competition, community composition and diversity, and responses to fire and grazing. Recent studies have been focusing on the role of mycorrhizae on soils and ecosystem processes. A study on Konza Prairie across various long-term fire frequency and grazing treatments showed that frequent fire and increased N-availability both increased mycorrhizal hyphae, the glomalin-related soil proteins that they produce, and consequently soil aggregation (Wilson *et al.* 2009). The findings of a close positive correlation between mycorrhizal abundance and soil aggregation, and C and N sequestration indicated that mycorrhizal fungi have important roles on ecosystem processes and there are serious consequences to their loss from ecosystems.

A cross site study of local adaptation in mycorrhizal symbioses indicates that local adaptations between plants and their mutualistic fungi maximizes nutrient uptake and plant fitness (Wilson et al. in review). 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.

A study, currently in review, indicates that nitrogen availability can mediate arbuscular mycorrhizal mutualism and parasitism. This collaborative study by LTER investigator Gail Wilson, Nancy Johnson (Northern Arizona University), and Michael Miller (Argonne National Laboratory) proposes a trade balance model to account for the interactive effects of C, N, and P on AM function. The model predicts that, depending upon P-availability, N-enrichment may either increase mutualistic benefits or exacerbate plant growth depressions because N controls both the C-supply and the C-demand in AM symbioses. A series of fertilization experiments using naturally occurring combinations of plant hosts, AM fungi, and soils from three different grasslands that varied naturally in their soil nutrient composition (Konza Prairie LTER, Fermi National Lab, and Cedar Creek LTER) were used to test the predictions of the trade balance model. Results of our experiments support the hypothesis that N-availability interacts with P-availability in determining the net effect of AM fungi on their host plants. Nitrogen enrichment of N-limited soil increases plant C-supply as well as fungal C-demand. The influence of this on AM fungal biomass and mycorrhizal benefits for plant biomass varies with P-availability: N-enrichment strengthens AM mutualism in P-limited soil, but it decreases mutualism or even generates parasitism in P-rich soil.

Wilson and Williamson (2008) also completed experiments to assess the potential use of a new fungicide for field experiments to manipulate mycorrhizal fungal abundance. In prior studies, the fungicide benomyl was used to successfully suppress arbuscular mycorrhizal fungi (AMF) in both field and greenhouse experiments. Unfortunately benomyl is no longer manufactured and is not available for experimental use. Wilson and Williamson evaluated the potential for the fungicide Topsin M® (topsin) to suppress mycorrhizal symbiosis in both field and greenhouse experiments. Topsin reduced AMF colonization of the obligately mycotrophic, warm-season grass Andropogon gerardii with a large and significant reduction in plant biomass production. Topsin also reduced AMF colonization of the facultatively mycotrophic, cool-season grass Pascopyron smithii but did not significantly reduce biomass production. Fertilization with nitrogen and phosphorus compensated for reductions in biomass due to the application of fungicide, indicating that plant growth responses were due to suppression of mycorrhizal-mediated nutrient uptake. These results suggest that topsin is useful alternative for mycorrhizal suppression in field experiments, and we currently have experiments underway at the Konza LTER sites using this approach.

Analyses by Jumpponen and colleagues of the foliar fungal communities that inhabit oaks in urban and native stands indicate that phyllosphere communities are hyperdiverse (~1,000 Operational Taxonomic Units [OTUs] that serve as proxies for species) and distinct among urban

and native stands (Jumpponen & Jones 2009). These hyperdiverse communities maintain substantially higher richness and diversity in the native stands and several taxa occur preferentially in the native stands: Amphispaeriaceae, Elsinoaceae, Filobasidiaceae, Gnomoniaceae, Helotiaceae, Mycosphaerellaceae, and Taphrinaceae are all more frequent in 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. Rhizosphere fungal communities show similar patterns: overall richness is high (>1,000 OTUs), the native stands more specious and the communities in native and urban stands distinct. Families that commonly form ectomycorrhizas (EcM) (Boletaceae, Cortinariaceae, Sclerodermataceae, Thelephoraceae and Tuberaceae) represent most common taxa. Among the EcM families Boletaceae and Tuberaceae were more abundant in the urban stands than in the native stands, whereas Sebacinaceae and Thelephoraceae occurred at greater frequencies in the native stands.

Using Remotely Sensed Data to Estimate ANPP in the Flint Hills Region.

Spatially-explicit measurements of ANPP are critical to the proper management and understanding of climatic and anthropogenic influences on tallgrass prairie, yet accurate, detailed, and systematic measurements of ANPP over large geographic regions are difficult to obtain. For these reasons, Konza LTER investigators (led by K. Price) examined the use of the Normalized Difference Vegetation Index (NDVI) to model ANPP for the tallgrass prairie. Many studies have established a positive relationship between the NDVI and ANPP, but the strength of this relationship is influenced by vegetation types and can significantly vary from year-to-year depending on the specific model, land use and climatic conditions. The goal of this study was to develop a robust model using the Advanced Very High Resolution Radiometer (AVHRR) biweekly NDVI composite values to predict tallgrass ANPP. This study was conducted using the Konza Prairie Biological Station as the primary study area, with supporting data from other sites near Manhattan, Kansas, used to validate the model. The dominant study period was 1989 to 2005. The optimal period for estimating ANPP using AVHRR NDVI composite datasets was AVHRR composite period 30 (late July). The Tallgrass ANPP Model (TAM) explained 53% (r^2 = 0.53, r = 0.73) of the year-to-year variation. The TAM outperformed other model estimates of ANPP (An 2009). These results indicate the importance of region-specific models for estimating ANPP, and suggest that ecosystem specific ANPP models are needed to improve global scale ANPP estimates.

Cross-Site, Synthesis and Network-level Studies.

Konza LTER scientists continue to be active in studies and synthetic analyses that extend beyond the border of the Konza Prairie site. For example, Konza LTER scientists in the aquatic group participated in the LINX II cross-site nitrogen tracer experiments to assess factors controlling retention and release of nitrate in stream ecosystems. Results of these studies were published in Nature (Mulholland et al. 2008) and Limnology and Oceonography (Mulholland *et al.* 2009, Hall et al. 2009), indicating that efficiency of nitrogen removal decreases as nitrogen loading increases. Other recent cross-site and synthetic publications included patterns and controls of plant community dynamics (Chalcraft *et al.* 2008, Cleland *et al.* 2008), applications of phenological studies to assess 21st century climate change (Morrisette *et al*. 2009), synthetic review of the impacts

of climate change on terrestrial ecosystems (Garrett *et al.* 2008, Marshall *et al.* 2008, Gerten *et al.* 2008, Luo *et al.*2008), a synthetic review of non-target and invasive species in restored ecosystems (Baer et al. *in press*), a synthetic comparison of the value of ecosystem goods and services in native and restored ecosystems (Dodds et al. 2008), and a new conceptual framework for assessing ecosystem responses to chronic resource alterations induced by global changes (Smith *et al. in press*).

Below is a list of Konza Prairie LTER publications for the period January 2008 – present (July 20, 2009).

Publications - 2008

2008

Anderson, J.F., T.D. Parrish, M. Akhtar, L. Zurek and H. Hirt. 2008. 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 **74**: 1726-1730.

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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.

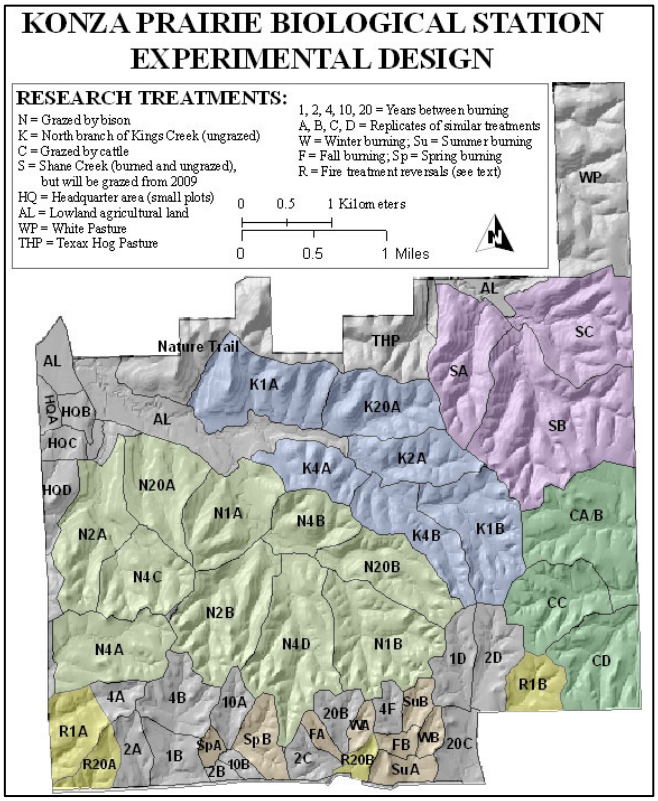


Figure. 1. Konza Prairie site experimental design, and watershed-level fire and grazing treatments. Watersheds with native ungulate (bison) grazing ('N') are light green, and cattle-grazed watersheds ('C') are dark green. The new patch-mosaic grazing study will include the Shane Creek watersheds ('S', light purple). 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 first year (2008-2009) 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 (2008-09):

Fire Ecology in Tallgrass Prairie.

In 2008-2009, 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 of 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. 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 2009 (the "isoscapes" study), and preliminary results were presented at the 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 Hills. Our data suggests that management-related burning could be spread out in time

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.

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), and presented at various management-related meetings (e.g., the 2009 Natural Areas Research Conference in Nashville, TN).

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 2009 we eliminated the third tower site as we completed two years of measurement across topographic positions on the same watershed. The Konza LTER site currently maintains 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). The results of this study will be used to interpret the long-term responses to the fire reversal treatments, and are 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 2008-09, 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, 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 (NA – Konza Prairie, KS) and South African (SA – Kruger National Park) savanna grasslands.

To increase our understanding of the spatio-temporal dynamics of fire-grazing interactions, we are initiating 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 requires substantial field preparation, and coordination with collaborators in the Department of Animal Sciences. In 2008-09, 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 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 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 will be used to assess the applicability of a new model of ecosystem responses to chronic changes in levels of resource availability (Smith *et al. in press*).

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.

A second major project examining the effects of climate and climate change in these grasslands utilizes field-scale Rainfall Manipulation Plots (RaMPs) in which the timing and amounts of rainfall events are being experimentally manipulated in intact native tallgrass prairie plots (Fig. 3). This project, currently supported with additional funds from USDA, DOE and NSF LTREB, is allowing us to assess the effects of altered precipitation regimes on individual plant ecophysiological responses, plant community composition, and ecosystem-level processes. Details regarding the experimental approach and the initial results of this experiment

are provided in Fay et al. (2000, 2003), and some recent results are highlighted in the accompanying 'Findings' section of this report. In addition to core long-term response variables on plant, soil and ecosystem responses to changes in timing of rainfall and warming, this project is currently being used in 2008-09 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 Harnett and students have shown that the belowground population of meristems (bud bank) plays a primary role in plant population dynamics and in influencing community diversity, stability, and ANPP. A new LTER study initiated in fall 2008 is examining the environmental factors regulating 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 "threshold bud bank density hypothesis" for resistance to exotic species invasions, and 3) the hypothesis that the bud bank is a stabilizing feature that buffers grass population responses to environmental change. The role of proximal environmental cues in bud production, dormancy and tiller initiation is being examined experimentally in 6 C_3 and C_4 grass species. The influence of bud banks on population stability is being tested by relating bud bank densities to plant population model parameters derived from the 30-yr LTER record of abundance of each grass species. Relationships between bud bank densities and community invasibility by exotic species will also be quantified. In addition, new rainfall interception and irrigation plot experiments recently established in grazed and ungrazed sites on Konza (Ph.D. research by Ben Vanderweide) will examine 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, topo-edaphic 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.

Temperature Sensitivity of Soil Respiration: A Multi-Site Study.
Konza soil was acquired in 2008 as part of an NSF-funded continental-scale examination of the temperature sensitivity of soil organic matter (Craine, Fierer and McLauchlan). These soil samples are currently being incubated long-term across a range of temperatures. The research aims to understand the differences in temperature sensitivity of microbial respiration of labile and recalcitrant soil organic matter, how this sensitivity changes with N availability, and determine the underlying factors that can explain continental variation in this sensitivity. This experiment is being complemented locally (and with LTER support) with an examination of landscape-level variation SOM temperature sensitivity at Konza, being conducted in 2009.

Restoration Ecology and Grasslands.
The Konza Prairie LTER program continues to build a unique legacy of projects addressing fundamental issues in restoration ecology, with a new restoration chronosequence being initiated as part of LTER VI. Ecological restoration represents a test of our understanding of community and ecosystem assembly. Elucidating factors that constrain the colonization and persistence of species in a community is at the heart of theory development on community assembly rules. A combination of field experiments and a suite of measurements are being continued during LTER VI to test the hypothesis that intraspecific variation in a dominant species has hierarchical consequences for community and ecosystem re-assembly, across multiple species pools and over a broad geographic region. Experimental restoration plots to address this hypothesis were established at Konza Prairie (and additional non-LTER field sites) in 2006 with a dominance gradient of cultivar and non-cultivar (native) source populations of the prairie grasses and a variety of prairie forbs. A split-plot design will be used to test whether native source populations and cultivar source populations of the grasses and their initial dominance influence plant diversity and ecosystem processes. We also continue to make measurements of community and ecosystem responses in a long-term restoration experiment initiated in 1998 at the Konza site, and have added new plots to evaluate the role of mycorrhizae in restoring diversity of the forb plant component in restored grasslands. A new restoration experiment is also to be initiated in LTER VI - the Restoration Chronosequence Experiment. Planning for this project is being led by Sara Baer. We recently finalized the experimental design and identified a field site in a field currently under cultivation near the Konza headquarters. We met with Agronomy management personnel to establish a timeline for establishing the restorations, and to assess the feasibility of continuing to cultivate portions of the field as the chronosequence expands over the next 10 years. Seed collection is underway, with an initial restoration to take place in spring 2010.

Studies of Woody Vegetation Expansion into Grasslands.
Forest encroachment and the expansion of shrubs into grasslands is a widespread phenomenon, occurring in grasslands around the world. This is a serious conservation concern in tallgrass prairies, where woody plant encroachment leads to losses of grassland species and declines in biodiversity. There are also important potential changes in ecosystem processes accompanying grass-to-woodland conversions, though these have not been well documented in many grasslands. Woody plant increases can be directly attributed to alterations in land management (reduction in fire frequency) and may be indirectly facilitated by other factors (increased CO_2 concentration, N deposition, habitat fragmentation, etc.). We have been assessing the causes and consequences of this ecosystem conversion from 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.

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 2008-09, 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. 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.

Ectomycorrhizal fungi in riparian gallery forests and in urban green oases
We continued a research effort led by LTER scientist Dr. Ari Jumpponen to investigate the ectomycorrhizal fungus species richness in urban/suburban green oases (including arboreal trees in parks and on campuses). This program targets the beneficial fungi that colonize and inhabit roots of 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 primary hypotheses are that native stands maintain higher fungal species richness, higher diversity and are functionally more diverse than the urban stands. The findings will contribute to better understanding of diversity, species richness and community function in native and urban environments. In 2008-09, the program was expanded to target two defined fungal guilds: 1) the beneficial fungi that colonize and inhabit roots of trees in genus *Quercus* (oaks) and 2) fungi that inhabit the foliage of the native oak (*Quercus macrocarpa*). Konza Prairie LTER serves as a location for endemic riparian gallery forests that create a contiguous network of native stands connected at the nodes to larger tributaries. The urban stands are isolated oases with environmental stresses different from those in native stands. Targeting urban stands also provides a convenient avenue for outreach activities. Thus far, we have engaged Manhattan City authorities including Manhattan City Park Parks and Recreation managers, Manhattan City Foresters, and Kansas State University Grounds Managers. Most importantly, this program was used as one of the platforms in an engagement activity to bridge rural schools and research universities. This activity, in collaboration with the Kansas State University's Center for Science Education, generated a hands-on classroom unit for a middle school in Great Bend, KS.

Grassland Stream Studies.
Grassland stream studies continue to be an important component of the Konza LTER program. Hydrology of Konza streams is being 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, Dodds and his students continued experiments to assess in-stream N transformations, and the role of benthic substrate heterogeneity in streams using a

combination of field sampling and laboratory studies. 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, and started baseline aquatic sampling for patch-burn grazing. A new PhD student (Alex Resinger) initiated new studies of the consequences of woody plant invasion for denitrification in streams and surrounding riparian areas, providing needed linkages between terrestrial and aquatic components of the grassland landscape. Three adjacent reaches were delineated from two branches of King's Creek, a USGS benchmark stream and focal site for many LTER aquatic studies. The three reaches comprise different riparian vegetation: grassy, woody, and woody vegetation removed. Potential and actual denitrification were measured along longitudinal transects away from the stream in each reach. LTER scientists

LTER investigators Whiles and Gido continued investigations of stream community structure function, stream food web dynamics, and patterns and controls of secondary productivity in grassland streams. Long-term monitoring of fish communities in 2009 represent the 13th 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.

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 we there is little data on how it may impact headwater streams.

The experimental stream facility on Konza continues to be used for mechanistic studies of stream ecosystem function and structure. In 2009, a new mechanistic study on the relationship between aquatic consumers and ecosystem process rates, including denitrification, was initiated. In addition, major papers describing the interactive effects of disturbance and species composition on stream ecosystem function were published this year (Bertrand et al. 2009, Murdock et al. in press) and others are in preparation.

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). Beginning in May, 2009, an additional method for collecting and directly measuring the CO_2 in groundwater was begun: downhole gas samplers. These are still undergoing testing, but hold promise for direct measurement of gases in groundwater and isotopes of C in the CO_2, that will allow quantification of the soil-CO_2 contribution to the groundwater CO_2. If successful, these can be deployed in any water well, and relatively quickly determine CO_2 content directly.

Application of a Spatially-Distributed Ecohydrology Model to Konza Prairie (Bob McKane and others). The USEPA, Georgia Institute of Technology, and Kansas State University have collaborated 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 km^2 Kings Creek Watershed at the Konza Prairie. Data visualization tools built into the model provide a spatial and temporal understanding of patterns of nutrient uptake and turnover in plants and soils, and terrestrial flow pathways of water and nutrients to surface waters. For example, 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 km^2 Flint Hills ecoregion of eastern Kansas. This project will also provide the necessary computational and decision support capabilities for generating spatially-explicit fuel load data in support of regional air quality assessments. The air quality modeling component of this work is being conducted under separately funded projects by Kansas State University and EPA Region 7.

19th Annual Konza Prairie LTER Investigator's Workshop.
The Konza Prairie LTER program hosted its 19th annual LTER Workshop on March 28, 2009, at the recently dedicated 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 2009 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, University of California Santa Cruz, and Yale 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.

Information Management.
Information management continues to be an essential activity for the Konza Prairie LTER program. We hired a new Information Manager (Adam Skibbe) in 2008, and after a period of overlap with our

prior IM (Jincheng Gao), we transitioned back to a single IM in 2009. Additionally, we hired two new part time staff members to assist Mr. Skibbe on some of our goals, a program assistant and archivist (Carol Gadbury) and an undergraduate data assistant (Samantha Miles).

In 2009 we continued to work towards our existing long-term goals but also added several new focal areas and components to 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 work 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.

This year, in addition to upgrading existing spatial datasets, we are working towards making a series of historic spatial data available, as well as planning for a new more complete geographic information system. We continue to offer our spatial datasets as downloads (.e00 interchange or .shp shapefiles) and their associated FGDC ESRI and EML metadata. In addition, Skibbe has been working in conjunction with other LTER information managers to develop a network wide online GIS mapping interface. In addition to this shared resource, we are also beginning work on replacing our existing online mapping (ArcIMS) products with newer more robust ArcGIS Server online maps.

One new focus of the Konza LTER IMS has been on organization and digitization of all original field data. Our archives were moved off site to a new location providing us the opportunity to focus on creating a better organized library of our historic field data. Our archivist (Carol Gadbury) has been in charge of this organization and we are now at a point where we can identify what exists and exactly where to find it. An additional goal to the physical archiving of these field data is to have 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 2009 we purchased a blade enclosure and our first, more efficient, blade server to begin replacing our older rack servers. Our first blade houses our new database server which runs the latest version of SQL Server (2009) and is set to replace our previous database setup later this year. In addition, we plan on replacing several of existing servers with two new blades in an iSCSII SAN solution. This solution would allow us to have fail over between all of our virtualized machines and ensure stability in our IMS. In addition to this system, we are expanding our storage from 900 GB to 5 TB in order to keep up with our growing data requirements.

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 metadata database, making it easy for users to find specific personnel information and related publications.

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 2008-09: 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 REUS students working on Konza through the KSU REU site grant. 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).

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:

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

- studies of prokaryotic community composition and responses to disturbance, directed by Barny Whitman (UGA);

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

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

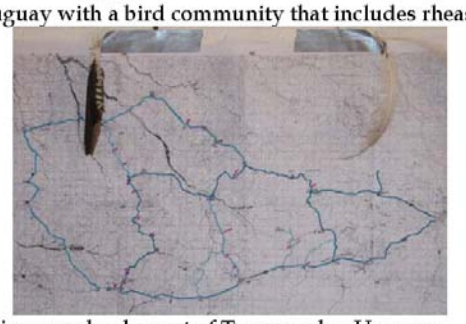
Konza LTER scientists are also involved in a variety of international collaborative efforts. For example, Konza LTER scientists and scientists from South Africa are conducting collaborative studies of ecological responses to fire and grazing in North American and Southern African grasslands [J. Blair (KSU), M. Smith (Yale), Alan Knapp (CSU), Scott Collins (UNM) and collaborators in South Africa (Kevin Kirkman and Richard Fynn at the University of KwaZulu-Natal, Pietermarizburg)]. Konza co-PI David Hartnett maintains collaborations with colleagues in Botswana, and has supported exchanges of graduate students there. In 2008, Hartnett re-visited field sites in Botswana with another LTER scientist (Gail Wilson) and LTER graduate student Jacqueline Ott to conduct research on bud bank ecology and the regulation of dynamics of southern African grasslands. In addition, Hartnett and Joern are Co-Directors of the Institute for Grassland Studies at KSU, which promotes international collaborative research on grassland ecology, and in 2009 Hartnett led a field class on a trip to South Africa and Botswana. In 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 (see photos below from 2008-09 field season). 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. Konza Prairie continues to host numerous visits by international scientists and students, including (in 2008-09): Dr. Marjan Jongen of the Instituto Superior de Agronomia, Lisbon, Portugal; Matilde Alfaro-Barrios of Averaves-Investigación y Conservación, 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 Koppenaal, Groningen University, The Netherlands. In 2009: Nicholas Zaloumis, University of Cape Town, South Africa).

Linking the Ecology of Migratory Birds in the Native Grasslands of North and South America
International Supplement to Konza Prairie LTER V (DEB-0218210, B.K. Sandercock, bsanderc@ksu.edu)

Upland Sandpipers breed in Kansas but winter in Uruguay with a bird community that includes rheas.

Grasslands in Uruguay are mainly private lands and are heavily impacted by intensive livestock grazing.



Native grasslands west of Tacuarembo, Uruguay were surveyed for Upland Sandpipers (pink).

Field crew in 2008-09 included a U.S. grad student, and a scientist and two undergrads from Uruguay.

Khara (left), a U.S. grad student, instructs Natalia, (right), an undergrad from Uruguay, on data coding.

Matilde (left), a scientist with Averaves, instructs Luciano (right), an undergrad, on bird marking.

An Upland Sandpiper individually marked with color-bands and a radio transmitter.

Patterns of wear in the wing feathers are used to determine age-class and sex of each sandpiper.

Konza-Related Extramural Grants active during the current funding period (2008-2009)
One of the strengths of the Konza LTER program has been our ability to leverage LTER funding, and LTER experiments and infrastructure, to garner additional support for ecological research at the Konza Prairie site, which often complements our LTER studies (e.g., provides mechanistic explanations for observed long-term responses, or aides in regionalizing Konza results). Below is a list of additional (non-LTER) grants that were active during the 2008-09 reporting period.

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 (So. 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.

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

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.

Harrington, J., Jr., 2007-2008. Ecological forecasting. Kansas NASA Space Grant, $12,800

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.

Heisler, J.L., and A.K. Knapp. 2006-2008. Dissertation research: Sensitivity of grassland ecosystems across the Great Plains to present and future variability in precipitation. EPA STAR Fellowship Program, $93,000.

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

Joern, A. 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.

Jumpponen, A. 2004-2008. Collaborative Research: Functional significance of "dark septate" endophytes in grassland and meadow ecosystems in western north America. NSF-DEB, $268,838.

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, S.L. Collins and M.D. Smith. 2005-2008. Collaborative Research: Convergence and contingencies in savanna grasslands. NSF Ecology & Ecosystem Studies Programs, $830,000.

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