

Konza Prairie LTER

Methods Manual

2025

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²Konza Prairie Research Natural Area, a preserve of the Nature Conservancy and part of the National Science Foundation Long-Term Ecological Research (LTER) program, is operated by the Division of Biology, Kansas State University.

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Abiotic Data

AET01

Title: Konza Prairie grass reference evapotranspiration

Purpose: Estimated evapotranspiration from a hypothetical short grass with a height of 0.12 m, a surface resistance of 70 s m⁻¹, and an albedo of 0.23 (no water stress).

Date data commenced: 11/05/2000

Date data terminated: ongoing

Location of Sampling Stations: Headquarters Weather Station

Frequency of Sampling: Hourly

Variable Measured: Grass Reference Evapotranspiration

Methods: This data is derived from LTER dataset AWE01. For instrumentation and field methods see the AWE01 Methods Manual entry.

Instrumentation:

Campbell LI200X pyranometer

Met One 024 wind direction sensor

Met One 014 wind speed sensor

Campbell HMP35C temperature and rh probe

Campbell 107 temperature probe

Campbell HFT3 soil heat flux plate (measures heat flux in W m⁻², only used in calculating evapotranspiration)

AGW01

Title: Long-term Measurement of Groundwater Physical and Chemical Properties from Wells on Watershed N04D

Purpose: To study temporal variations in shallow groundwater chemistry in an unplowed tallgrass prairie watershed; to examine stream-aquifer interactions in that watershed; to calculate chemical denudation rates of a prairie setting underlain by limestone and shale; to examine sources and sinks of dissolved species in groundwater at that watershed.

Date data commenced: 01/19/1990

Date data terminated: ongoing

Location of Sampling Stations:

Samples are regularly collected from wells in watersheds N01B and N04D and from surface water locations in watersheds N01B, N04D, and N02B at Konza Prairie Biological Station. Specific information about each watershed's sampling locations follows below.

Watershed N04d wells: Thirty-five wells are located in the lower third of the N04d watershed. In 1988 and 1990, the U.S. Geological Survey, Lawrence, KS, drilled 31 wells at 20 sites within the N04D watershed at the Konza Prairie Research Natural Area. In 1997, the Konza LTER program funded drilling of an additional 4 wells at 3 additional sites. The older wells range in depth from about 2 to 13 meters; the newer wells are about 12 m, 21 m, 27 m and 37 m deep. Wells are completed in discontinuous alluvium/colluvium or in bedrock. Some of the bedrock-aquifer wells are nested to include two to three limestones in the Permian-aged bedrock. Thin (1-2 meter) limestones alternating with thicker (2-4 meter) shales in the region; limestones are aquifers. Most bedrock wells sample the Morrill Limestone Member of the Beattie Limestone (stratigraphically lowest), two wells sample an unnamed, discontinuous limestone with the Stearns Shale, and several wells access one or two levels in the Eiss Limestone Member of the Bader Limestone. A single well, not presently used, samples the Middleburg Limestone Member of the Bader Limestone (stratigraphically highest). The wells sites or nests comprise four transects running approximately east-west across the watershed drainage, and occupy the lower one-quarter of the watershed surface area.

Watershed N01b wells: Five wells are located in the lower portion of the N01b watershed. All of the N01b wells were drilled in November of 2020 by the Kansas Geological Survey, Lawrence, KS. The wells are located at three sites along a single east-west transect perpendicular and to the west of the watershed drainage. They range in depth from about 13 to 28 m, with two of the wells screened in the Eiss limestone and three screened in the Morrill Limestone. The two Eiss Limestone wells are adjacent to two Morrill Limestone wells at mid and upper hillslope positions. The third Morrill Limestone well is located at a lower position adjacent to riparian woody vegetation. No Eiss Limestone well was installed there because the surface elevation is below the horizon of the Eiss Limestone. The well transect is located near the watershed outlet.

Surface water sampling locations: Stream samples are collected near the outlet of watersheds N01B, N04D, and N02B (1-1 stream location) when the stream is flowing continuously, which tends to occur in spring and early summer. Additionally, two upgradient stream locations (3-1 stream, 4-1 stream) are sampled in watershed N04D. Those locations coincide with a pool of stream water that exists year-round and is fed by groundwater discharge from the Upper Eiss Limestone.

Frequency of Sampling:

Water samples and water level measurements have been collected regularly since 1990. However, the procedures and variables collected have evolved over time. The sections below describe approaches during specific time intervals.

1990 through 2019: Water samples are currently collected every 4-6 weeks, as weather permits, from up to 7 wells and 2 stream locations; depth-to-water is measured in all wells (1994-present). In 1990, samples were collected quarterly from all wells and all 4 stream locations that were not dry. From 1991-1993, water samples were collected from all wells and all 4 stream locations that were not dry.

Variable Measured: 1) Depth to water (water level) in wells.
2) Dissolved Na, K, Li, Ca, Mg, Sr, Ba, SO₄, Cl, F, NO₃-N, HPO₄-P, total alkalinity, Si, and B in all well or stream samples with sufficient water.
3) Field pH in some well and stream samples.

Field Methods:

Water level measurement:

Depth to water is measured after removing the PVC well cap and allowing the well to 'breathe' for several minutes, using a water level meter (Solinst 101, with flat polyethylene cable and stainless-steel probe). Reference points (measuring points) are marked on the well casings. Reproducibility of measurements is on the order of 6 mm (0.02 feet). Prior to April 2015, well depth was also measured.

Water chemistry:

Field personnel wear powder-free latex or other plastic gloves during all procedures. Wells are bailed until approximately two well-casing-plus-annular space volumes of water have been removed. Samples for chemical analysis are carefully bailed from the wells using a one-liter Teflon® bailer suspended on Teflon®-coated steel wire. Samples are emptied into dedicated, pre-cleaned (with distilled water in the lab), dried, and pre-rinsed (with groundwater in the field), 2-liter, low-density polyethylene (LDPE) jugs using a Teflon® bottom-emptying device inserted into the bailer after it is removed from the well. Jugs are capped securely and carried to the field vehicle for further processing.

For stream-water samples, dedicated, pre-cleaned (with distilled water in the lab), dried, 2-liter LDPE sampling jugs are rinsed with stream water and the rinse water discarded downstream or on the stream bank. Samples are collected by orienting the jug mouth upstream and submerging it until the bottle fills. Sample is intended to collect moving water whenever possible, so that precise sampling location may vary by ± 1 m up and down the stream. After they are filled, jugs are capped securely and carried to the field vehicle for further processing.

After each well sampling, the bailer and suspension wire are rinsed with distilled water. Between each sampling date, the bailer is disassembled and acid washed in the laboratory. Dedicated sampling jugs are rinsed with distilled water between sampling events, and periodically acid washed using 5% HCl.

At the field vehicle, samples are filtered through 0.45-micron filters using a peristaltic pump. For low suspended-solids samples, disposable filters (e.g., Millipore HAWP 0.45-micron filter disks) installed in Teflon housings or disposable low-capacity 0.45 μ cartridge filters, or small-capacity 0.45 μ disposable cartridges are used. For high suspended-solids samples, disposable high-capacity 0.45 μ cartridge filters are used (e.g., Gelman Groundwater Sampling Capsule). Filtered samples are collected in acid-washed 250 milliliter (mL) low-density polyethylene (LDPE) bottles: one bottle is filled to capacity and a second bottle, pre-weighed, is filled with approximately 250 mL of sample. Bottle lids are sealed with Parafilm, placed in pre-chilled reflective cold-storage bags and the bags are stored in a chilled ice chest for transport to the laboratory

Field pH is measured on the first aliquot collected from the bailer through the bottom-emptying device into pre-cleaned, dedicated, 60-mL narrow-mouth LDPE bottles. Bottles are filled from the bottom to overflowing; a rinsed (distilled-deionized water) pH electrode (whose calibration against buffer solutions with nominal pH of ~4 and ~7 is verified just before and just after sample is collected) is inserted into the bottle, displacing water to waste. The cap mounted on the pH electrode is screwed securely onto the 60-mL bottle, rendering it airtight. The bottle with electrode is placed in insulating material to minimize temperature change. pH and water temperature are recorded after the pH and mV reading has not changed for at least 10 seconds.

2020 to present: Water samples are collected approximately every 4 to 6 weeks or as weather permits from up to 11 wells and 5 surface water sites using methods that are largely consistent with those used in prior years. All wells are sealed with a PVC cap aside from when they are being sampled. To collect samples from wells, we remove the cap and measure the depth-to-water and total depth of each well using a Solinst water level meter. We then bail each well until the saturated volume of water had been removed at least two times. Once the wells are purged, we collect additional bails of water and discharged them into a beaker and a 1 L graduated cylinder for compositional analysis. Prior to discharging the water, we added a bottom emptying device to the bailer to minimize gas exchanges while discharging the sample. We measure field parameters (pH, temperature, conductivity, and dissolved oxygen (DO) concentration) from water in the graduated cylinder while it is overflowing with fresh sample. We draw samples from the beaker for laboratory analysis of major anions and cations and water stable isotopes. Those samples are filtered with 0.45 μ m syringe filters and discharged directly into storage bottles. We stored samples in 30 or 60 HDPE bottles for alkalinity and major cation and anion analyses, clear 2 mL glass vials for water isotope samples, and 60 mL amber glass bottles for non-purgeable organic carbon (NPOC) and total dissolved nitrogen (TDN). Bottles for NPOC and TDN are cleaned prior to use by soaking in a 2% hydrochloric acid solution, rinsing with ultrapure water (18 M Ω), and then baking at 250°C overnight. To collect stream samples, we followed identical procedures except no bailing is needed and water samples are drawn directly from the stream channel and

probes for field parameters are placed in the stream water column. We measure field parameters for both groundwater and surface water using an Oakton PC 450 pH and conductivity probes and a Professional Series YSI Pro 2030 DO probe. We calibrate each probe before use and rinse them with deionized water between sampling sites.

Laboratory Methods:

1990 through 2019: Bottles are transferred to a ~7-degree refrigerator at the end of the field day. The pre-weighed bottles filled with ~250 mL of water are weighed. Concentrated nitric acid is added in the proportion of 1 mL nitric acid for every 50 mL of sample. The bottle is weighed after acid addition and lids are re-sealed with Parafilm for storage until analysis. This is the acidified sample.

One 50-mL aliquot from each unacidified, filtered, full bottle (unacidified sample) is removed for the alkalinity titration. Alkalinity is titrated in the laboratory using 0.02 N H₂SO₄; the end point is determined by the slope method and checked against the Gran titration method. The initial pH of this sample (before addition of any titrant) is recorded as laboratory pH. Beginning in 2015, alkalinity has also been determined using a 855 Robotic Titrosampler autotitrator. A ~5-mL aliquot of each unacidified sample is used for anion determination by ion chromatography. A ~25 mL aliquot of each acidified sample is used for determination of cations by ICP-OES. The analytical techniques are summarized briefly below.

1991 - 2016: F, Cl, NO₃-N, PO₄-P, and SO₄ are determined by ion chromatography with a Dionex 4000i ion chromatograph (EPA Method 300.0). Analysis is accomplished by suppressed conductivity detection using IONPAC AS4A-SC separator column, IONPAC AG4A-SC guard column, and an anion self-regenerating suppressor. Eluent is 1.8 mM Na₂CO₃ and 1.7 mM NaHCO₃ pumped at a rate of 2 mL/min. The suppressor is continuously regenerated with distilled-deionized water. The sample loop size is 25 microliters; 5 mL of sample is spiked with 50 microliters of 100X eluent to minimize the water dip interference with F and Cl determination. Samples are analyzed twice and the average of the two analyses reported as long as the difference between the two is less than 3% of the lower value. Quality control samples from various sources are used to check accuracy of the determinations.

2016 - present: F, Cl, NO₃-N, PO₄-P, and SO₄ are determined by ion chromatography with a BRAND MODEL (EPA Method 300.0). Analysis is accomplished by suppressed conductivity detection using IONPAC AS23 separator column, IONPAC AG23 guard column, and a AERS-500 anion self-regenerating suppressor. Eluent made from Dionex AS 23 Concentrate and after 10x dilution is 4.5 mM Na₂CO₃ and 0.8 mM NaHCO₃; eluent is pumped at a rate of 1 mL/min. The suppressor is continuously regenerated with distilled-deionized water. The sample loop size is 25 microliters; 5 mL of sample is used for the analysis. Samples are analyzed twice and the average of the two analyses reported as long as the difference between the two is less than 3% of the lower value. Quality control samples from various sources are used to check accuracy of the determinations. ICP-OES (Instruments SA, Inc., JY-138Ultrac) is used to determine dissolved concentrations of Na, K, Li, Ca, Mg, Sr, Ba, Si, and B using a ~25 mL aliquot from the acidified sample. All determinations are made in duplicate and checked against quality control samples from various sources and/or against Standard Reference Materials water samples from the National Institute of Standards and Technology (NIST).

May 2018 - Dec 2018: For AGW011 data: From May through December 2018 water chemistry samples, there was a long holding time for anion determination (SO₄, Cl, F, NO₃-N) due to equipment failure, making the reported data potentially unreliable.

2020 to present: We analyze alkalinity and major ion concentrations for all samples within a month of collection in the Geology Department and Division of Biology at Kansas State University. Water samples are stored in a laboratory refrigerator until they are analyzed. Cation samples are preserved by adding trace-metal grade nitric acid to a final volume of 0.2%. Similarly, NPOC and TDN samples are preserved by adding concentrated hydrochloric acid to a final volume of 0.2%. For alkalinity measurements, we have used two techniques. During samples collected from Oct. 31, 2021 to Feb. 27, 2022, we used Gran alkalinity titrations with a glass burette and 0.02 N sulfuric acid titrant. Then, for the remainder of the samples, we used end-point (pH 4.5) titrations using a ThermoScientific OrionStarT910 pH Titrator again with 0.02 N sulfuric acid titrant. These methods gave consistent results when performed on replicate samples. We measure anion (F⁻, Cl⁻, NO₃⁻, SO₄²⁻) and cation concentrations (Na⁺, K⁺, Mg²⁺, Ca²⁺, Sr²⁺) using Thermo Scientific ICS-1100 Ion Chromatographs. We measured NPOC and TDN using a Shimadzu TOC-L. For IC and TOC-L analyses, quality control procedures include requiring a correlation coefficient of at least 0.995 for successful calibration and periodic analysis of calibration verification samples during each run. We measured the δ¹⁸O and δ²D of water isotope samples at 0.1 and 0.5‰ precision, respectively, using a Picarro L-i2130 water analyzer. Results are expressed in delta notation relative to Vienna Standard Mean Ocean Water (VSMOW).

Form of Data Output:

All data are recorded onto a computer spreadsheet (Microsoft Excel). Several derivative properties are calculated by the spreadsheet. These include total dissolved solids, hardness, milliequivalents of cations and anions, and charge balance.

Summary of All Changes:

From 1991 through 1993, all wells that contained water were sampled and water chemistry determined. From 1993 – only a subset of wells has been sampled for water chemistry.

Jan 1991 - April 1994: Cations measured were Na, K, Ca, Mg by AAS.
April 1994 - May 1997: Cations measured were Na, K, NH₄-H, Ca, Mg by IC.
May 1997 - present: Cations measured are Na, K, Li, Ca, Mg, Sr, Ba, B, and Si by ICP-OES.

April 1998- April 2000: Si also determined by the molydosilicate method (Standard Methods #426B) using a Spectronix 2000 UV-VIS spectrometer.

May 2018 - December 2018: water chemistry samples, there was a long holding time for anion determination (SO₄, Cl, F, NO₃-N) due to equipment failure, making the reported data potentially unreliable.

2020 to present – the monitoring effort started by Dr. Gwen Macpherson was picked up by Dr. Matthew Kirk

AGW02

Title: Measurement of Groundwater Physical and Chemical Properties from Wells of Contrasting Land Uses near King Creek

Purpose: To study variations in ground water chemistry between an agricultural site (A) and a grassland site (P).

Date data commenced: 05/17/1996

Date data terminated: ongoing

Location of Sampling Stations:

Fourteen wells total: Seven wells are located in an agricultural (A) site near HQ. The site is currently under a mix of cultivation and restoration plots. Historically, the site was cultivated from sometime between 1939 and 1950 to present. Seven wells are located in K01a (P). This site is an old field that was planted with brome prior to 1976. It has not been grazed and is burned in the spring every 1-2 years. Both sets of wells are approximately 100 m from Kings Creek. The two sites are approximately 1 km apart.

Frequency of Sampling: Monthly, as weather permits.

Variable Measured: Nitrate-N, ammonium-N, soluble reactive phosphate (SRP), total nitrogen (TN), total phosphorus, dissolved organic carbon (DOC).

Field Methods: Depth to water and depth to bottom of the well are measured; amount to be removed is calculated using wells volume chart and two times the volume is removed to “flush” the well. Samples for nutrient determinations are collected from wells A-2, A-5, P-2, and P-5. At the end of a bailing session, bailers and all other equipment are cleaned with well water at Konza HQ. Data sheet is available.

Laboratory Methods:

Upon return to the laboratory, field workers pour each of 4 water samples into 3 separate cleaned vials and store these in the lab freezer.

One vial is analyzed for **inorganic** nitrogen (N) and phosphorous (P). A second vial is run for **DOC**. The third vial is run for TN and TP. At the completion of all analyses the vial with maximum volume is stored in the freezer as an archived sample for 10 years from date of collection.

Nitrogen and phosphorous nutrient determinations are analyzed on an OI Analytical Flow Solution IV (FSIV) instrument. Simultaneous determinations of nitrate and SRP may be analyzed from a single aliquot by use of a stream splitter. In the same manner, TN and TP are analyzed simultaneously. Ammonium determinations are performed as a single analyte. A windows-based software program (WINFLOW) purchased with the FSIV allows automation of the analyzer. Regression curve information, graphic display during analyses,

and calculated results provide the operator immediate information about samples. At the completion of each run, data files are electronically stored on instrument's computer and also transferred to offsite backup data storage.

Inorganic Nitrogen (N) and Phosphorous (P) (nitrate, ammonium, and SRP) are run within one month of sample collection.

As nitrate and SRP are analyzed simultaneously, dual standards (both N and P) are utilized. Concentrations range from 0.5 to 1500 $\mu\text{g/L}$ NO_3^- -N and 0.5 to 150 $\mu\text{g/L}$ SRP. Ammonium standards range from 0.5 to 200 $\mu\text{g/L}$ NH_4^- -N. The concentrations of most well water samples are found within these ranges of concentrations. As these samples are analyzed, they are checked immediately by the Lab Research Assistant (RA) and rerun immediately if values are off. Data are entered by the Lab RA into the Master Excel spreadsheet.

Total N and total P concentrations values are determined in a two-step process, utilizing a Total Persulfate digestion (modified from J.J. Ameal American Environmental Laboratory, October 1993) followed by NO_3^- and SRP analysis on FSIV instrument. In general, a series of 8 duplicated standard solutions, a digestion recovery standard (i.e. spike solution; ATP and urea), 4 spiked samples, an oxidizing reagent blank and 92 samples comprise each digestion run. Dual standards (both NO_3^- and SRP) range in concentration from 0 to 2000 $\mu\text{g/L}$ NO_3^- -N and 0 to 200 $\mu\text{g/L}$ SRP. Pyrex screw-top digestion tubes are used for this procedure utilizing potassium persulfate as the oxidizing agent in an autoclave digestion for 55 minutes at 17 psi. A 3N sodium hydroxide reagent is used in this procedure for maintaining proper pH. Digested samples are then analyzed for NO_3^- -N and SRP using FSIV instrument. A digestion recovery value is calculated from digestion recovery standards and spiked samples and then applied to all samples to determine corrected TN and TP concentration values. Approximately 1 liter of cocktail solution (matches the final chemical composition of samples and reagents) is digested along with samples and used as the carrier solution for FSIV determinations.

DOC is analyzed using Shimadzu TOC-L. Five milliliters of sample are shaken and filtered through ash-free glass fiber filters into cuvettes. Samples are acidified with 0.1 mL 2N hydrochloric acid for removing dissolved CO_2 during purging process prior to combustion in analyzer. Standards of 0, 1, 2 and 5 mg/L are included in each run at the beginning, middle, and end of each set of unknowns. These are used to generate regression curves for each run to calculate concentration values of samples.

1996-2011: DOC were analyzed in batches of 50 using a Shimadzu T-5000 by a trained student worker. It was possible to do approximately three batches or 150 samples per week. Through the duration of the DOC run, a continuous strip-chart will simultaneously print out after each sample is analyzed by the TOC-5000. When analysis is completed, the strip-chart is read and the mean values (MN) will be recorded onto the original data sheet, which was started in the preparation process. These mean values will be later referred to as "peak areas". At this point, the yyyy-mm-dd, site, and mean values should be filled out and can be transferred into the TOC Data Template. These files can be located by "Stream Nutrient on 'Sunfish' (J:)" in the "ALL TOC INSTRUCTIONS, TEMPLATES, AND DATA" folder under "TOC Detailed Instructions".

Further detailed instructions, such as operations processes and data entry techniques are also available in this folder.

Once the template is opened, save a new file using the run date of the most recent DOC run. Fill in the “Peak Area” cells for the DI blanks, standards, and samples. The standards are used to generate a regression curve (R^2), in which the spreadsheet will automatically calculate and graph this value, as well as fill in the mg/L conversion. After the curve is developed, the concentrations of the unknowns are determined by plotting the “peak areas” onto the regression.

The values of the areas are copied into the “TOC Compilation” spreadsheet, located next to the TOC Data Template. The R.A. will further analyze the data and determine any outliers or unusual values for possible re-runs of the samples.

Data is compiled annually, checked by lead PI, RA and archived by the IM.

Summary of All Changes:

2002: May - a bailer came untied and lodged into the bottom of A-2. Numerous attempts have been made to remove it but all have failed.

2005: May 2005 to March 2006 - unable to open P-7. Top hinge had to be permanently dismantled to gain access.

April – December 2006 – “meso” well sample added to the sampling regime for monitoring purposes.

2008: August - a large portion of the agricultural well area (A-1, 2, 3, 4 and 7) was sprayed with round-up.

2009: Summer - the metal housing around the PVC access tube of P-4 is full of water. The metal lid was not closed properly and it rained. The access tube was covered with plastic at the time; rain did not get into the well. Waiting for the water to evaporate—housing is water tight.

2009: Autumn - there is significant ground “heaving” around the bases of P-2, P-4, P-5 and P-6. The cement pad at the base of the housing has been raised up out of the ground 1 to 4 inches.

2010: March 5. Repairs have been made to the prairie wells (P-2, 3, 4, 5, 6 and 7). Dr. Gwen Macpherson recommended packing the base of the cement slab with bentonite to eliminate the possibility of overland water flow into the wells. Water from Kings Creek was used to wet down the bentonite. P-4 also has a large crack in the cement base; the cement is “pulling” away from the metal housing. Bentonite was poured into the crack and around the base.

For future reference: Bentonite for these repairs was obtained from KSU Grain Science via Dr. Keith Behnke. It is used as a binder in animal feed. Other sources are drilling operations (Associated Environmental in Manhattan) and cheap kitty litter.

August 2011: Shimadzu TOC-L installed. This analyzer automatically reads and stores DOC concentration of unknowns using a regression curve generated by known concentration standards.

January 2014 – adding samples from ColW (Columbia well) and HQW (Headquarters well) to the sampling regime. ColW is at the SE corner of the Columbia storage building. The source well for ColW covers the Columbia building, experimental stream and greenhouse (meso) north of the gas pumps. HQW is north of the Barn. The headquarters’ source well covers all HQ buildings, the corral, and over to the cabins.

December 2016 – consistent problems with the spigot and pump at ColW. Switching to the old “meso” well. We will continue calling the sample ColW.

April 2017 – a 1L bailer came untied and is now stuck in A-1. Bailer cannot be retrieved.

July 2019 – the expected depth at well P-3 was 23.0 feet. Starting in July it moved up to 22.7 feet. As of February 2020, it seems to be settled at 22.4 feet. Field data sheets have been changed.

February 2020 – problems with the spigot at HQW. We will switch to a spigot south and east of the barn; at the SE corner of the Researchers Shop and continue calling it HQW.

January 2023 – There has been a change in the depth at 3 wells; A-1, P-1, and P-3. These changes were noticed at various dates during the 2022 season.

	was	new depth
A-1	32.0	32.5
A-2	34.6	34.6
A-3	28.2	28.2
A-4	20.2	20.2
A-5	35.7	35.7
A-6	20.1	20.1
A-7	28.0	28.0
P-1	23.4	21.1
P-2	27.5	27.4
P-3	23.0	22.4
P-4	18.5	18.5
P-5	28.0	28.0
P-6	17.8	17.8
P-7	22.8	22.8

AGW03

Title: High frequency groundwater level and temperature in selected wells at N03d

Purpose: Record groundwater level and groundwater temperature to study groundwater recharge patterns

Location of Sampling Stations:

Selected wells (usually 3-5Mor, 3-5-1More, 4-6Mor, 4-6Eis1, 4-6Eis2, 4-2Mor). Sensors may be moved for special projects.

Frequency of Sampling: every 5 minutes

Variable Measured: temperature (°C), water pressure (m), air pressure (psi)

Field Methods:

Remove loggers carefully from the well. Store in Styrofoam sleeves out of direct sunlight. Download data onto Solinst Leveloader. Measure and record the depth to water in the well using an E-line. Clear sensor of data. Check knots on the doubled nylon string before redeploying sensor.

Laboratory Methods:

Transfer data from Solinst Leveloader onto computer using Leveloader and/or Levelogger software. Perform barometric compensation correction in the software. Save software generated files and also export uncompensated and compensated cvs files. In Microsoft Excel, use elevation of the measuring point on the wells and the depth-to-water measurement taken just before re-deploying sensor to calculate groundwater elevation in units of meters above mean sea level. Delete data recorded while sensor was out of the well. Plot results of water level elevation and temperature and compile into annual data sets.

Form of Data Output:

Excel file. Variables included are:

Date	Date and time of measurement
Elevation	Groundwater elevation above mean sea level (m amsl)
Temperature	Groundwater temperature, °C

Missing data for groundwater elevation and temperature are blank.

Summary of All Changes:

Software: Leveloader 1.02 (2003-2015), Levelogger 1.5.0.15 (2003-2015), Levelogger 4.1.1 (2011-2015), Levelogger 4.2.0b3 (2015-2017), Levelogger 4.3.0 (July 2017 – present). Sensors: Barologger 3001LT, F5, M1.5 (4-6 Mor, 2003; 3-5Mor, 2003-2014); Levelogger Model 3001LT, F15, M5, LL01 (4-6Mor, 2003); Levelogger Model 3001LT, F15, M5, LL02 (4-6Mor, 2004; 3-5Mor, 2004-2010; 2-4Mor, 2010; 2-5Mor, 2010; 3-5Mor, 2010-2014); Levelogger Model 3001LT, F15, M5, LL03 (3-5-1Mor, 2004-2010); Barologger Gold (3-5Mor, 2015-present); Levelogger Gold (3-5Mor, 2015-2017);

Levelogger Gold (4-6Eis1, 2015-present); Levelogger Gold (4-6Eis2, 2015-present);
Levelogger Gold (4-2Mor, 2015-present); Levelogger Edge (3-5Mor, 2017-present).

Quality Assurance:

Sensors are checked for accuracy before initial deployment. Water-level accuracy is tested in a 3.05 m (10 ft) clear plastic pipe partially filled with water. Water-temperature accuracy is tested using Digi-Sense thermocouple thermometer (Type T) that has a resolution of 0.1°C and accuracy of $\pm 0.2\%$ of the reading.

Instrumentation:

Solinst unvented Leveloggers and Barologger (pressure transducers).

AGW04

Title: Measurement of stream chemical properties during growing season rainfall events at konza prairie, 2024

Purpose: To assess event-level variation in stream concentration-discharge relationships in watersheds with variable extents of woody plant encroachment.

Date data commenced: 04/01/2024

Date data terminated: 07/31/2024

Location of Sampling Stations:

Stream samples were collected near the outlet of watersheds N01B, N02B, and N04D (1-1 stream location) at Konza Prairie Biological Station when the stream was flowing continuously, which tends to occur in the spring and early summer. The three watersheds have similar underlying bedrock of alternating layers of Permian-aged limestone (1-2 meter) and shale (2-4 meter), where the limestone layers act as aquifers and the shale layers act as leaky aquitards. When limestone aquifers are filled with water during the growing season (spring and early summer), the outcropping layers supply streambeds with enough water for discharge to occur near watershed outlets.

Variable Measured:

Temperature (°C), stream pH, solutes, isotope oxygen 18

Methods:

Stream water samples (500mL) were collected at each watershed (N01B, N02B, and N04D) every hour just before and during seven different storm events using YSI ProSample P autosamplers deployed near the watershed outlets. Precipitation samples from the seven storm events was also collected. Additionally, streamflow pH and temperature were measured every five minutes using HOBO data loggers between April 30th, 2024 and July 11th, 2024, with weekly calibration of the instrumentation. In total, 268 stream water and precipitation samples were collected over the 92-day period. Most storm events occurred overnight, spanning over two dates. Additionally, some watersheds could not be sampled during events due to technical difficulties. The following dates are when storm events occurred, and which watersheds samples were collected from.

Event 1	05/01/2024-05/02/2024	N01B and N02B
Event 2	05/06/2024-05/07/2024	N01B, N02B, and N04D
Event 3	06/02/2024	N01B and N02B
Event 4	06/07/2024-06/08/2024	N01B, N02B, and N04D
Event 5	06/08/2024-06/09/2024	N01B, N02B, and N04D
Event 6	06/18/2024-06/19/2024	N01B and N04D
Event 7	07/03/2024-07/04/2024	N02B and N04D

Once collected, samples were capped and transferred to Dr. Kirk's Aqueous Geochemistry lab at Kansas State University for refrigeration and storage. Samples were filtered using

45µm paper filters to determine sediment load (mg/L) and were then divided into five separate containers for analysis of alkalinity concentrations (meq/L), major anion and cation concentrations (mg/L), non-purgeable organic carbon (NPOC mg/L), total dissolved nitrogen (TN mg/L), and stable water isotopes (d18O and dD).

Anion samples were refrigerated and stored until analysis. Cation samples were preserved by adding trace-metal grade nitric acid to a final volume of 0.2%. Similarly, NPOC and TN samples are preserved by adding concentrated hydrochloric acid to a final volume of 0.2%. For alkalinity measurements, we used end-point (pH 4.5) titrations using a ThermoScientific OrionStarT910 pH Titrator again with 0.02 N sulfuric acid titrant. We measure anion (F-, Cl-, NO₂-, Br-, NO₃-, and SO₄²⁻) and cation concentrations (Na+, NH₄⁺, K+, Mg²⁺, Ca²⁺, and Sr²⁺) using Thermo Scientific ICS-1100 Ion Chromatographs. We measured NPOC and TN using a Shimadzu TOC-L. For IC and TOC-L analyses, quality control procedures include requiring a correlation coefficient of at least 0.995 for successful calibration and periodic analysis of calibration verification samples during each run. We measured the stable water isotope samples at 0.1 and 0.5‰ precision, respectively, using a Picarro L-i2130 water analyzer. Results are expressed in delta notation relative to Vienna Standard Mean Ocean Water (VSMOW).

Trace element concentrations were measured for event seven with coordination of the Earth, Environment, and Resource Sciences department at the University of Texas at El Paso. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was used to analyze the samples, and results were reported in parts-per billion (ppb).

All samples were analyzed within one month of collection. Some additional amount of sample (125mL) was frozen to preserve for future analysis, if needed. All field collection bottles were thoroughly rinsed with DI water before being redeployed into the field.

The maximum cover of each species across the two seasonal samplings was used as the cover value for each species in a quadrat. Maximum percent cover of each species was averaged across the two quadrats in each subplot. Plot-level species richness was calculated by summing the total number of species from all subplots within a plot. Plot-level diversity (Shannon's diversity index: H') was calculated from the average cover of each species across all 12 subplots within a plot.

Quality Assurance:

Certified reference standards, analysis of blanks and calibration certification samples.

AMC01

Title: Growing season microclimate by topographic position for annually-burned and 4-year burned watersheds at Konza Prairie

Purpose: Dataset contains 30min averages of many variables used to record changes in microclimatic conditions. Microclimate sensor stations were arrayed in discrete topographic positions (upland, slope, lowland) in 4 watersheds: 1D, 1B, 4B, 4F. No microclimate sensor stations were present in upland-1D or lowland-4B because eddy flux towers are present in these locations. Similar microclimate data is available from these flux towers during the time period of this study.

Date data commenced: 01/01/2010

Date data terminated: 12/30/2013

Location of Sampling Stations:

Konza Prairie watersheds: 1D, 1B, 4B, and 4F

Frequency of Sampling: April – September

Variable Measured:

Soil moisture, wind speed, air temperature, and relative humidity

Methods:

Microclimate sensor stations were established in 10 locations in March 2010. Data collection occurred primarily during the growing season (April-September) until September 2013. Sensor stations were arrayed in discrete topographic positions (upland, slope, lowland) in 4 watersheds: 1D, 1B, 4B, 4F. No microclimate sensor stations were present in upland-1D or lowland-4B because eddy flux towers are present in these locations and collected microclimate data during the time period of this study.

The microclimate of each plot was characterized during the growing season by measuring soil moisture at 10 cm, 30 cm and 100 cm (Hydraprobe II, Steven Water Monitoring Systems), wind speed (3-cup anemometer, Wind Sentry, Campbell Sci), air temperature (100K thermistor, Betatherm) and relative humidity (HM1500, Humirel) enclosed in a radiation shield (41003, RM Young). Infrared temperature was measured with an IRR-P sensor, (Apogee Instruments). Measured relative humidity and air temperature were used to calculate the vapor pressure deficit (VPD) for each plot. All sensors were sampled every 10 s using CR10X dataloggers at each plot (Campbell Scientific Inc., Logan, UT) and 30-min averages were recorded.

Missing data are signified with the value ‘-9999’.

ANA01

Title: Weekly, Seasonal and Annual Measurement of Precipitation Volume and Chemistry Collected as Part of the National Atmospheric Deposition Program

Purpose: Collect wetfall samples and record precipitation volume for analysis of atmospheric input of nutrients to tallgrass prairie.

Date data commenced: 08/17/1982

Date data terminated: 04/23/2019

Location of Sampling Stations: Headquarters weather station (HQC).

Frequency of Sampling: Weekly, continuous from August 17, 1982.

Variables Measured – KSU laboratory:

- 1) Amount of precipitation (inches/week), checked against headquarters weighing rain gauge (Ott Pluvio²).

Variables Measured – Central Analytical Laboratory (CAL), Illinois State Water Survey, Champaign, IL:

- 1) Conductivity of precipitation ($\mu\text{S}/\text{cm}$).
- 2) pH of precipitation.
- 3) Concentrations of the following ions (mg/l): SO_4 , NO_3 , NH_4 , Cl, PO_4 , Na, K, Ca, and Mg.

Methods:

The Aerochem Metrics Wet/Dry collector is equipped with a movable lid and a precipitation sensor that electronically signals the lid to uncover a "wet" side bucket during precipitation events and recover the wet side when precipitation ceases. Every week (Tuesdays), the wet side bucket is replaced with a clean bucket. The previous week's wet bucket is fitted with a clean lid and transported back to campus in a plastic bag and transporting box. On campus, the bucket, lid and contents are weighed. A weekly field form records time and date on and off, a daily precipitation record of amounts, information about sample contamination and equipment operation. The sample is carefully transferred into a cleaned 1-liter polyethylene bottle (provided by CAL) and then shipped to Central Analytical laboratory (CAL) along with the field form. This procedure is followed every week regardless of the amount of precipitation collected.

More detailed instructions concerning bucket changing, and pH and conductivity determinations are available in the NADP Field Operators Manual located in Bushnell Rm 215. Used collection supplies (lids and buckets) are collected for six weeks and then returned to CAL for cleaned replacements.

Every four weeks, the dry side bucket is also changed and replaced with a clean bucket. No analysis of dryfall is currently done by NADP. As of April 1992, we have requested regular updates of data for our site from the NADP/NTN Coordination Office.

Routine Maintenance:

Weekly, the precipitation sensor should be checked for proper operation (if touched, or if a drop of water is placed on the sensor, the lid should move to uncover the wet side bucket). Also, the sensor and moveable lid should be cleaned monthly using distilled water and fine stiff brush. The underside of the lid should be cleaned each month, using a clean Kimwipe and distilled water. The top of the lid should also be kept clean and free of snow or ice accumulation. During freezing weather, rain/ice storms may cause the lid to freeze to either bucket. The frozen lid must be broken free as soon as possible to avoid burning out the motor on the sampler and to assure the quality of the precipitation sample collected. Finally, once a year, the foam underside of the lid should be changed. A new seal will be shipped from NADP automatically.

Before onset of winter, the backup DC battery supply (located in black plastic box on the ground below the collector) should be removed and taken to KSU Vehicle Maintenance to be "load-tested" for voltage. This was installed on 8-29-91 to provide improved continuation of electrical supply and to protect the collection equipment. The battery is routinely changed every 2 years.

Approximately every two to three years NADP will arrange for an inspector to survey the site, calibrate the rain gauges, and observe the operator to determine necessary changes in operations. Last site visit was April 24, 2019.

Note: Missing data are signified with the “.”.

Summary of All Changes:

Starting January 26, 1993, a one-year study to compare two-week collections of precipitation to the on-going weekly collections was initiated at our site. Data was provided in the same manner as the existing set. The two-week sampling study ended on April 4, 1995.

January 04, 2005: pH and conductivity no longer measured at KSU (field pH and field conductivity on data reports and summaries).

April 1, 2011: Daily precipitation amounts now measured by Ott Pluvio² rain gauge at headquarters weather station.

January 1, 2017: Starting January 1, 2013, we do not provide the seasonal total data (ANA012), which can be calculated from the weekly data or downloaded from NADP.

May 1, 2019: We do not provide weekly data (ANA011), which can be found and downloaded from NADP website (<https://nadp.slh.wisc.edu/sites/ntn-ks31/>). Search site for KS31.

APT01

Title: Daily Precipitation Amounts Measured at Multiple Sites across Konza Prairie

Purpose: Monitor rainfall in tallgrass prairie on a long-term basis.

Date data commenced: 06/01/1982

Date data terminated: ongoing

Location of Sampling Stations:

Headquarters weather station (grid C-16): Ott Pluvio². Headquarters 2 (C-16)

Prairie rain gauges:

Belfort Weighing Rain Gauges:

020A (C-30) 002C (M-31)

N04D (J-27)-upland 020B (O-28)

K04B (T-23) 004B (G-26)

N01B (P-23) N02B (H-22)

N04D (L-23)-lowland

HOBO Data Logging Rain Gauges:

R01A (C-30) 002C (M-31)

N04D (J-27)-upland 020B (O-28)

K01B (T-23) 004B (G-26)

N01B (P-23) N04D (L-23)-lowland

Frequency of Sampling: Continuous sampling at headquarters weather station. Continuous from April 1 to October 31 for rain gauges on prairie.

Variable Measured: Daily amounts of precipitation (mm)

Methods:

Precipitation is measured at headquarters by an Ott Pluvio² rain gauge (continuous remotely monitored). It was installed in March 2010 at the Konza HQ site. Data is collected and processed by a Campbell Scientific (CR800) data logger and downloaded via wireless internet every 15 minutes.

Prior to the Pluvio, Belfort weighing rain gauges, one with a seven-day clock HQ1 and one with a 24-hour clock HQ2 (equipped with a wind screen) were used to record HQ precipitation. Additionally, nine other Belfort weighing rain gauges are installed on the Konza Prairie. Gauges in R01A, 004B, N02B, N04D (upland and lowland), K04B, and N01B have 24-hour clocks for finer resolution of storm events. Gauges in 020A and 002C have seven-day clocks. The prairie rain gauges are not operated during the winter months (November-March).

HOBO Data Logging Rain Gauges (RG3-M) were installed in April 2022 (004B, N04d-upland, 002C, N01B, and N04D-lowland) and April 2023 (R01A(formerly 020A), 020B, and

K01B (formerly K04B). Both Belforts and HOBOS will run concurrently for the remaining life of the Belfort RGs.

Routine Maintenance:

Charts on all Belfort weighing rain gauges require changing each week. Catch buckets in the rain gauges are emptied at the time of chart changing except when the headquarters rain gauge is winterized with antifreeze (see Belfort manual for details). Clock mechanisms require rewinding each week and pens must be refilled with ink. The prairie rain gauges are sealed with plastic in the winter. Following significant precipitation events, the level of the antifreeze/water mixture in the buckets should be checked to avoid overflow. The antifreeze/water system should be discarded and refilled if dilution of the antifreeze past levels of protection occurs. Strip charts are read and hand entered into APT012.

The Ott Pluvio² rain gauge processing program sends an e-mail to the weather station technician when the bucket is 3” below capacity and needs to be emptied. In the fall, antifreeze is added to the collection bucket, see Ott Pluvio² manual for details. SAS formats data and generates daily date and 15 minute data from the Ott Pluvio² rain gauge.

Data is downloaded from the HOBOS units every 1-2 weeks. They will follow the same operation schedule of April 1 to October 31 as the Belfort RGs. The HOBOS will be calibrated every year before they are deployed in the spring.

Additional information:

Headquarters rain gauge 1 in operation continuously since June 1982; prairie rain gauges at 004B, 020B and 002C (south end) in operation since April 1983. Rain gauges at N01B, N04D (flume), N04D (prairie chicken blind) and 020A in operation since 02 April 1986. Rain gauge HQ2 has been in operation since 20 August 1986. All rain gauges except gauges at Headquarters are to be operated from April 1 to October 31 each year.

Note: Missing data are signified with the “.”, and all data missing for the station of 4b, 2c, n4du, n2b in 2022.

Summary of All Changes:

1982: only operated one ‘HQ’ rain gauge

4/1/1983: added 20B, 2C, 4B

4/1/1983 – 4/1/1986: operating four rain gauges (HQ, 20B, 2C, 4B)

4/2/1986: added K01B, N01B, N02B, N4DF, N4DU, R01A (total of 10 rain gauges)

8/20/1986: added HQ2 (total of 11 rain gauges)

3/19/2010: use new rain gauge ‘Ott Pluvio2.’ We have the new measures from this new rain gauge. For the period of ‘2010-01-06’ – ‘2011-03-28’ added comments ‘old rain gauge’ in the comment column

3/29/2011: shut off the ‘HQ2’ and old ‘HQ’ rain gauge (current: total of 10 rain gauges – 020B, 002C, 004B, HQ, K01B, N01B, N02B, N4DF, N4DU, R01A)

6/3/2018: converted apt011 data structure to long format, then merged with apt012 data; cleaned up blank cells, updated old rain gauge code to the current rain gauge code (watershed code)

March 2020: all nine Belfort RGs calibrated. Three units failed calibration and will not be opened this season; 004B, 002C, and N4D upland.

April 2021: N02B Belfort stopped working after less than one month and cannot be calibrated. Functioning RGs remain at 020B, N01B, N04D – lowland, K01B, and R01A. R01A is the only seven-day clock, all others are 24-hour clicks. We are looking into replacing all units.

April 2022: The five remaining Belfort RGs were opened on April 1. They were not calibrated (normally done every other year) due to their precarious condition. Five HOBO Data Logging Rain Gauges (RG3-M) were purchased and will operate concurrently with the Belfort RGs. The new HOBOS represent 004B, N04D – upland, and 002C locations, which had no representation in 2021. N01B and N04D – lowland also had HOBOS running alongside the still functioning Belfort RGs.

April 2023: Three additional HOBO rain gauges purchased and have been placed at 020B, K01B, and R01A. The N02B location will no longer be monitored.

April 2024: R1a was shut down after one month. Inconsistent readings and it cannot be calibrated. The HOBO remains at this site.

June 10, 2025: Charts for the RGs are no longer available. All Belforts have been decommissioned and removed from KPBS. See APT013 for HOBO data.

APT02

Title: Monthly temperature and precipitation records from Manhattan, KS

Purpose: To measure the maximum, minimum and average temperatures and monthly total precipitation for Manhattan, KS.

Date data commenced: 01/01/1891

Date data terminated: 12/31/2006

Location of Sampling Stations: Weather Data Library in the computer system office of the Cooperative Extension Service of Kansas State University, Manhattan, Kansas (211 Umberger Hall). Phone: 785-532-6270

Frequency of Sampling:

Monthly

Methods:

Data set contains the monthly values of maximum, minimum, and average temperatures and monthly total precipitation for Manhattan, KS since 1891. Data are in three separate files, one for each measurement. Data comes from the Weather Data Library (<https://www.ncdc.noaa.gov/cdo-web/search?datasetid=GHCND> (link is external)) in the computer system office of the Cooperative Extension Service of Kansas State University, Manhattan Kansas.

ASD01

Title: Kings Creek Stream Hydrology and Chemical Analysis

Purpose: Periodicity and volume of stream flow and transport of inorganic materials in survey waters of Kings Creek. This is USGS data available at waterdata.usgs.gov.

Date data commenced: 04/01/1979

Date data terminated: 12/30/2006

Location of Sampling Stations: Lower Kings Creek

Frequency of Sampling:

15-minute interval:	Stream Discharge	
Periodic:	Alkalinity	Turbidity (Jackson units)
	Bicarbonate	Nitrogen (total organic, total, NH ₄ dissolved, suspended, NO ₂ + NO ₃)
	Calcium	Phosphorus (dissolved, total)
	Fluoride	Total dissolved solids
	Magnesium	Coliform
	Potassium	Water temperature
	Silica	Specific conductance
	Sodium	Sulfate
Monthly plus storm event:	Suspended sediment concentration and particle size Total dissolved solids (residue after evaporation)	
Quarterly:	Metals (dissolved and suspended separately): Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Selenium, Silver, Zinc	
Semi-annually:	Bed material particle size	Uranium
	Gross Alpha count	Gross Beta count
	Radium-226	Potassium-40

Methods:

See Biesecker, J.E. and D.K. Leifests. 1975. Water quality of hydrological benchmarks. USGS Circular 460-E.

Contact: Butch Laycock
U.S. Geological Survey, WRD
4821 Quail Crest Place
Lawrence, KS 66049
913-842-9909

ASD02

Title: Stream Discharge Measured at the Flume on Watershed N04D

Purpose: To study hydrology of streams draining tallgrass prairie catchments, to estimate surface losses of nitrogen (see data set NWC01), and to compare runoff and nutrient loss characteristics among four different burn frequencies (1-, 2-, and 4-year intervals, and unburned).

Date data commenced: 06/14/1985

Date data terminated: ongoing

Location of Sampling Stations:

Flumes are located at the base of each catchment ASD02/N04D; ASD04/N20B; ASD05/N01B; ASD06/N02B

Frequency of Sampling:

Stream gage height is recorded every five minutes on the CR-21X datalogger (Campbell Scientific Co.) up to 2012 at which point the depth logger was switched to a SUTRON Accubar Constant Flow Bubbler with integrated data logger. Each record also includes Julian day and time (discontinued in 1999 recorded hourly (see data set AWT02). Data were initially dumped at approximately one to two week intervals from the CR-21X memory to cassette tape (up to about 2000) or laptop computer (2012). Currently data are relayed via wireless to Bushnell Hall every 6 hours and backed up regularly. A computer program is used to reduce and summarize the five minute values into daily summary values and stormflow summary statistics.

Methods:

Until 2013, gage height is sensed by pressure transducers (Druck Model PDCR 10/D) and recorded on the CR-21X datalogger (Campbell Scientific Co.), or by a SUTRON Accubar Constant Flow Bubbler with integrated data logger. In 2013, pressure transducers were replaced with air bubblers with an integrated pressure sensor (YSI WaterLOG Bubbler/Pressure Sensor H-3553) and data are recorded on a CR800 datalogger (Campbell Scientific Co.) Conversion to stream discharge requires two steps:

1) Correction of measured gage height to actual gage height using direct measurements of gage made approximately three times per week with a ruler at a reference point at each flume. Until 2018, corrections were applied annually by conducting a linear regression between time-matched manual (x) and bubbler (y) measurements of gage height using all data collected in a year. All bubbler measurements of gage height from that year were then corrected with the resulting regression equation. Starting in 2018, a two-point regression method has been employed by examining the linear relationship between any two consecutive points with manual and bubbler measurements of gage height. Manual measurements are collected approximately three times per week, therefore corrections are applied with the same frequency. All these corrections have been applied separately to each sampling station. Each sampling station is tested for high flows one time per year by plugging the stilling well and filling the well with water to artificially increase gage height. Water level in the stilling well is measured with the aid of a clear plastic tube running through the plug that fills to the same height as the well.

2) Translating gage height to stream discharge using a rating curve.

Two rating curves employ geometric relationships which are assumed to be valid at certain stage heights. The relationship used for calculating discharge at gage heights > 18.25 cm is:

$$Qm^3/s = 4.64 \times 10^{-5} * s^{2.587}$$

The relationship used for calculating discharge at gage heights between 0-18.25 cm is: $Qm^3/s = 6.49 \times 10^{-5} * s^{2.4714}$

Where Q is discharge in cubic meters per second and s is gage height in cm. These equations were derived using procedures in Replogle, J. A., H. Reikerk, and B. F. Swindel.

1978. Water monitoring in coastal forest watershed studies. IMPAC Report 2, Vol. 3, No. 2. Southwestern Forest Expt. Station, USDA, Gainesville, Florida.

Form of Data Output:

Data are downloaded every one to two weeks until 2012 and have been downloaded at least every 24 hours since then.

Once corrected, data is stored on the LTER network. Daily and storm flow (five-minute value) summaries are available. Before 2005, only data for storm events were saved. Due to decreases in limitations of computer space, we are not saving complete hydrologic records for each watershed, and allowing individual users to convert height to storm peaks themselves for specific events they are interested in. Gage height data can be converted to discharge by using the equations above.

Summary of All Changes:

1. Change all the blanks cells for missing values before 2013(on Jan and Feb, 2021), after 2013 (on Aug, 2018)
2. Set the time min max to missing if there is zero flow during a day for all year's data (on Jan and Feb, 2021).
3. For data quality flags, on the flag columns, before 2013, put a missing code. After 2013 change blank to 'zero', what those meaning are: 1 = flag, 0=no flag, '.' = missing value (Aug, 2018, Jan and Feb, 2021).
4. For variables of volume, height, Sheight, CorrectedSheight, Discharge, RecHour etc, if any of the value is null or blank, will set them for missing value '!' (Feb 2021).

ASD04

Title: Stream Discharge Measured at the Flume on Watershed N20B

Purpose: To study hydrology of streams draining tallgrass prairie catchments, to estimate surface losses of nitrogen (see data set NWC01), and to compare runoff and nutrient loss characteristics among four different burn frequencies (1-, 2-, and 4-year intervals, and unburned).

Date data commenced: 01/01/1987

Date data terminated: ongoing

Location of Sampling Stations:

Flumes are located at the base of each catchment ASD02/N04D; ASD04/N20B; ASD05/N01B; ASD06/N02B

Frequency of Sampling:

Stream gage height is recorded every five minutes on the CR-21X datalogger (Campbell Scientific Co.) up to 2012 at which point the depth logger was switched to a SUTRON Accubar Constant Flow Bubbler with integrated data logger. Each record also includes Julian day and time (discontinued in 1999 recorded hourly (see data set AWT02). Data were initially dumped at approximately one to two week intervals from the CR-21X memory to cassette tape (up to about 2000) or laptop computer (2012). Currently data are relayed via wireless to Bushnell Hall every 6 hour and are backed up regularly. A computer program is used to reduce and summarize the five minute values into daily summary values and stormflow summary statistics.

Methods:

Until 2013, gage height is sensed by pressure transducers (Druck Model PDCR 10/D) and recorded on the CR-21X datalogger (Campbell Scientific Company), or by a SUTRON Accubar Constant Flow Bubbler with integrated data logger. In 2013, pressure transducers were replaced with air bubblers with an integrated pressure sensor (YSL WaterLOG Bubbler/Pressure Sensor H-3553) and data are recorded on a CR800 datalogger (Campbell Scientific Co.) Conversion to stream discharge requires two steps:

1) Correction of measured gage height to actual gage height using manual measurements of stage made approximately three times per week with a ruler at a reference point at each flume. Until 2018, corrections were applied manually by conducting a linear regression between time-matched manual (x) and bubbler (y) measurements of gage height using all data collected in a year. All bubbler measurements of gage height from that year were then corrected with the resulting regression equation. Starting in 2018, a two-point regression method has been employed by examining the linear relationship between any two consecutive points with manual and bubbler measurements of gage height. Manual measurements are collected approximately three times per week, therefore corrections are applied with the same frequency. All these corrections have been applied separately to each sampling station. Each sampling station is tested for high flows one time per year by plugging the stilling well and filling the well with water to artificially increase gage height.

Water level in the stilling well is measured with the aid of a clear plastic tube running through the plug that fills to the same height as the well.

2) Translating gage height to stream discharge using a rating curve.

Two rating curves employ geometric relationships which are assumed to be valid at certain stage heights. The relationship used for calculating discharge at gage heights > 18.25 cm is:

$$Qm^3/s = 4.64 \times 10^{-5} * s^{2.587}$$

The relationship used for calculating discharge at gage heights between 0-18.25 cm is: $Qm^3/s = 6.49 \times 10^{-5} * s^{2.4714}$

Where Q is discharge in cubic meters per second and s is gage height in cm. These equations were derived using procedures in Replogle, J. A., H. Reikerk, and B. F. Swindel.

1978. Water monitoring in coastal forest watershed studies. IMPAC Report 2, Vol. 3, No. 2. Southwestern Forest Expt. Station, USDA, Gainesville, Florida.

Form of Data Output:

Data are downloaded every one to two weeks until 2012 and have been downloaded at least every 24 hours since then.

Once corrected, data is stored on the LTER network. Daily and storm flow (five-minute value) summaries are available. Before 2005, only data for storm events were saved. Due to decreases in limitations of computer space, we are not saving complete hydrologic records for each watershed, and allowing individual users to convert height to storm peaks themselves for specific events they are interested in. Gage height data can be converted to discharge by using the equations above.

Summary of All Changes:

1. Change all the blanks cells for missing values before 2013(on Jan and Feb, 2021), after 2013 (on Aug, 2018)
2. Set the time min max to missing if there is zero flow during a day for all year's data (on Jan and Feb, 2021).
3. For data quality flags, on the flag columns, before 2013, put a missing code. After 2013 change blank to 'zero', what those meaning are: 1 = flag, 0=no flag, '.' = missing value (Aug, 2018, Jan and Feb, 2021).
4. For variables of volume, height, Sheight, CorrectedSheight, Discharge, RecHour etc, if any of the value is null or blank, will set them for missing value '.' (Feb 2021).

ASD05

Title: Stream Discharge Measured at the Flume on Watershed N01B

Purpose: To study hydrology of streams draining tallgrass prairie catchments, to estimate surface losses of nitrogen (see data set NWC01), and to compare runoff and nutrient loss characteristics among four different burn frequencies (1-, 2-, and 4-year intervals, and unburned).

Date data commenced: 01/01/1987

Date data terminated: ongoing

Location of Sampling Stations:

Flumes are located at the base of each catchment ASD02/N04D; ASD04/N20B; ASD05/N01B; ASD06/N02B

Frequency of Sampling:

Stream gage height is recorded every five minutes on the CR-21X datalogger (Campbell Scientific Co.) up to 2012 at which point the depth logger was switched to a SUTRON Accubar Constant Flow Bubbler with integrated data logger. Each record also includes Julian day and time (discontinued in 1999 recorded hourly (see data set AWT02). Data were initially dumped at approximately one to two week intervals from the CR-21X memory to cassette tape (up to about 2000) or laptop computer (2012). Currently data are relayed via wireless to Bushnell Hall every 6 hours and are backed up regularly. A computer program is used to reduce and summarize the five minute values into daily summary values and stormflow summary statistics.

Methods:

Until 2013, gage height is sensed by pressure transducers (Druck Model PDCR 10/D) and recorded on the CR-21X datalogger (Campbell Scientific Company), or by a SUTRON Accubar Constant Flow Bubbler with integrated data logger. In 2013, pressure transducers were replaced with air bubblers with an integrated pressure sensor (YSL WaterLOG Bubbler/Pressure Sensor H-3553) and data are recorded on a CR800 datalogger (Campbell Scientific Co.) Conversion to stream discharge requires two steps:

1) Correction of measured gage height to actual gage height using manual measurements of stage made approximately three times per week with a ruler at a reference point at each flume. Until 2018, corrections were applied manually by conducting a linear regression between time-matched manual (x) and bubbler (y) measurements of gage height using all data collected in a year. All bubbler measurements of gage height from that year were then corrected with the resulting regression equation. Starting in 2018, a two-point regression method has been employed by examining the linear relationship between any two consecutive points with manual and bubbler measurements of gage height. Manual measurements are collected approximately three times per week, therefore corrections are applied with the same frequency. All these corrections have been applied separately to each sampling station. Each sampling station is tested for high flows one time per year by plugging the stilling well and filling the well with water to artificially increase gage height.

Water level in the stilling well is measured with the aid of a clear plastic tube running through the plug that fills to the same height as the well.

2) Translating gage height to stream discharge using a rating curve.

Two rating curves employ geometric relationships which are assumed to be valid at certain stage heights. The relationship used for calculating discharge at gage heights > 18.25 cm is:

$$Qm^3/s = 4.64 \times 10^{-5} * s^{2.587}$$

The relationship used for calculating discharge at gage heights between 0-18.25 cm is: $Qm^3/s = 6.49 \times 10^{-5} * s^{2.4714}$

Where Q is discharge in cubic meters per second and s is gage height in cm. These equations were derived using procedures in Replogle, J. A., H. Reikerk, and B. F. Swindel.

1978. Water monitoring in coastal forest watershed studies. IMPAC Report 2, Vol. 3, No. 2. Southwestern Forest Expt. Station, USDA, Gainesville, Florida.

Form of Data Output:

Data are downloaded every one to two weeks until 2012 and have been downloaded at least every 24 hours since then.

Once corrected, data is stored on the LTER network. Daily and storm flow (five-minute value) summaries are available. Before 2005, only data for storm events were saved. Due to decreases in limitations of computer space, we are not saving complete hydrologic records for each watershed, and allowing individual users to convert height to storm peaks themselves for specific events they are interested in. Gage height data can be converted to discharge by using the equations above.

Summary of All Changes:

1. Change all the blanks cells for missing values before 2013(on Jan and Feb, 2021), after 2013 (on Aug, 2018)
2. Set the time min max to missing if there is zero flow during a day for all year's data (on Jan and Feb, 2021).
3. For data quality flags, on the flag columns, before 2013, put a missing code. After 2013 change blank to 'zero', what those meaning are: 1 = flag, 0=no flag, '.' = missing value (Aug, 2018, Jan and Feb, 2021).
4. For variables of volume, height, Sheight, CorrectedSheight, Discharge, RecHour etc, if any of the value is null or blank, will set them for missing value '.' (Feb 2021).

ASD06

Title: Stream Discharge Measured at the Flume on Watershed N02B

Purpose: To study hydrology of streams draining tallgrass prairie catchments, to estimate surface losses of nitrogen (see data set NWC01), and to compare runoff and nutrient loss characteristics among four different burn frequencies (1-, 2-, and 4-year intervals, and unburned).

Date data commenced: 01/01/1987

Date data terminated: ongoing

Location of Sampling Stations:

Flumes are located at the base of each catchment ASD02/N04D; ASD04/N20B; ASD05/N01B; ASD06/N02B

Frequency of Sampling:

Stream gage height is recorded every five minutes on the CR-21X datalogger (Campbell Scientific Co.) up to 2012 at which point the depth logger was switched to a SUTRON Accubar Constant Flow Bubbler with integrated data logger. Each record also includes Julian day and time (discontinued in 1999 recorded hourly (see data set AWT02). Data were initially dumped at approximately one to two week intervals from the CR-21X memory to cassette tape (up to about 2000) or laptop computer (2012). Current data are relayed via wireless to Bushnell Hall every 6 hours, where they are backed up regularly. A computer program is used to reduce and summarize the five minute values into daily summary values and stormflow summary statistics.

Methods:

Until 2013, gage height is sensed by pressure transducers (Druck Model PDCR 10/D) and recorded on the CR-21X datalogger (Campbell Scientific Company), or by a SUTRON Accubar Constant Flow Bubbler with integrated data logger. In 2013, pressure transducers were replaced with air bubblers with an integrated pressure sensor (YSL WaterLOG Bubbler/Pressure Sensor H-3553) and data are recorded on a CR800 datalogger (Campbell Scientific Co.) Conversion to stream discharge requires two steps:

1) Correction of measured gage height to actual gage height using manual measurements of stage made approximately three times per week with a ruler at a reference point at each flume. Until 2018, corrections were applied manually by conducting a linear regression between time-matched manual (x) and bubbler (y) measurements of gage height using all data collected in a year. All bubbler measurements of gage height from that year were then corrected with the resulting regression equation. Starting in 2018, a two-point regression method has been employed by examining the linear relationship between any two consecutive points with manual and bubbler measurements of gage height. Manual measurements are collected approximately three times per week, therefore corrections are applied with the same frequency. All these corrections have been applied separately to each sampling station. Each sampling station is tested for high flows one time per year by plugging the stilling well and filling the well with water to artificially increase gage height. Water level in the stilling well is measured

with the aid of a clear plastic tube running through the plug that fills to the same height as the well.

2) Translating gage height to stream discharge using a rating curve.

Two rating curves employ geometric relationships which are assumed to be valid at certain stage heights. The relationship used for calculating discharge at gage heights > 18.25 cm is:

$$Qm^3/s = 4.64 \times 10^{-5} * s^{2.587}$$

The relationship used for calculating discharge at gage heights between 0-18.25 cm is: $Qm^3/s = 6.49 \times 10^{-5} * s^{2.4714}$

Where Q is discharge in cubic meters per second and s is gage height in cm. These equations were derived using procedures in Replogle, J. A., H. Reikerk, and B. F. Swindel.

1978. Water monitoring in coastal forest watershed studies. IMPAC Report 2, Vol. 3, No. 2. Southwestern Forest Expt. Station, USDA, Gainesville, Florida.

Form of Data Output:

Data are downloaded every one to two weeks until 2012 and have been downloaded at least every 24 hours since then.

Once corrected, data is stored on the LTER network. Daily and storm flow (five-minute value) summaries are available. Before 2005, only data for storm events were saved. Due to decreases in limitations of computer space, we are not saving complete hydrologic records for each watershed, and allowing individual users to convert height to storm peaks themselves for specific events they are interested in. Gage height data can be converted to discharge by using the equations above.

Summary of All Changes:

1. Change all the blanks cells for missing values before 2013(on Jan and Feb, 2021), after 2013 (on Aug, 2018)
2. Set the time min max to missing if there is zero flow during a day for all year's data (on Jan and Feb, 2021).
3. For data quality flags, on the flag columns, before 2013, put a missing code. After 2013 change blank to 'zero', what those meaning are: 1 = flag, 0=no flag, '.' = missing value (Aug, 2018, Jan and Feb, 2021).
4. For variables of volume, height, Sheight, CorrectedSheight, Discharge, RecHour etc, if any of the value is null or blank, will set them for missing value '.' (Feb 2021).

ASM01

Title: Soil Water Content Measured by Neutron Probe

Purpose: To monitor spatial and temporal patterns of soil moisture in nine Konza Prairie LTER watersheds.

Date data commenced: 05/01/1983

Date data terminated: ongoing

Location of Sampling Stations:

All access tubes are located in Tully soils. Two tubes are in: R01A, R20A, 004B, 020B, R20B, 001D, R01B, and N04D. N20B has four holes. All tubes are located near species composition transects and are marked with conduit. Maps of all locations are available in Bushnell 207.

Frequency of Sampling:

Soil moisture is taken every two weeks from April 1 to November 1. November to March, readings are taken monthly when the temperature is above 20°F and there is no snow cover.

Methods:

Preferred method is for all sites to be measured on the same day. It will take two technicians 4-5 hours to complete all sites. A solitary technician will need 6+ hours. If readings are interrupted by significant rainfall, all sites must be re-done. A standard count is taken at the beginning of every session. At every site, the technician will check for water. If water is present, the lower depth reading(s) may not be taken. The probe must NOT be inserted into water. Tube depths vary from 75 cm to 200 cm. Holes were dug as deep as possible. Inserted into each hole is an aluminum access tube. The unit must be seated securely on top of the tube. The probe is then lowered to the varying depths at 25 cm increments and a reading is made and recorded. Each hole is closed off between readings with a rubber stopper and a metal top. Occasionally, these go missing due to animal activity. They will be replaced as soon as possible. Holes in the bison area are surrounded by an open metal framework 1.5 m x 1.5 m x 1 m to protect the access tubes from bison damage.

The neutron probes (Troxler, Model 4300) are stored in Bushnell Hall. Batteries are charged as needed. A single charge will last 3-4 months.

Maps of all soil moisture sites are located in Bushnell 215.

Precautions:

Only authorized technicians are permitted near the probes. All technicians are issued radiation badges that must be worn when using the probes. If recommended procedures are followed and the unit is not abused, operating the neutron probe is not hazardous. Make sure the probe is firmly latched in the unit before removing from the access tube. Do not immerse the probe into water. Specific safety and security procedures must be followed when transporting the probes via state and city roads.

Summary of All Changes:

1984: Tubes in 001C were added.

1989: January - a measuring stick was dropped into 020B #1, restricting depth readings to 75 cm. The stick lodged in the mud and could not be removed.

1989: July - tube #1 in 004B was damaged by a truck; it was replaced approximately 2 m away in December 1991. The new tube extended 23 cm above the ground instead of the normal 8 cm. In January 1993, the tube was cut to an 8 cm protruding height to conform to heights of other tubes. Thus readings from December 1991 to December 1992 were actually 15 cm above their indicated depth (i.e. 10, 35 and 60cm instead of 25, 50 and 75).

1992: Four tubes in N01B were abandoned because of potential contact problems between humans and bison. There are readings from 1983 until April 1992.

1998: Old probes (#1 and #2; Troxler, Model 3400) were replaced with Troxler, Model 4300. #3 arrived in January and #4 arrived in May.

1998: May to December - problems with access tube at N04D #2 tube-no readings.

1998: June - tubes in R01A (was 020A), R01B (was 020D) and R20A (was 001A) were added.

2001: Spring - fire reversal experiment began. This impacted the burn schedule of 4 watersheds.

001A became R20A. 001C became R20B. 020A became R01A. 020D became R01B.

2001: Continued, intermittent problems with N04D #2 from September 2001 to May

2002 and October 2002 to May 2003-no readings. From late May 2003 to March 2004, able to get readings but the probe was NOT completely seated on the access tube. Cause of problem, damage to access tube from bison activity.

2004: March - Unable to get readings from either N04D tube-both damaged by bison activity. In late May, cut off the upper edge of access tubes (less than 2 cm removed from top). Bison barriers put out around all tubes in the bison area (N04D and N20B).

June 2005 to June 2006: Chronic problems with #3. The unit was in and out of Troxler's TX and SC repair shop. During this time, readings were predominantly done by #4.

June 2006 to February 2009: chronic problems with #4. In and out of Troxler's SC repair shop. During this time, readings were predominantly done by #3.

2006: New stand for taking standard counts has been built. The original stand was 25 cm. According to the Troxler manual, it should have been 25 inches. There have been no changes in the readings.

July 2010: All access tubes were supposed to have a standardized height of 8cm (protruding aboveground). Most of the tubes were not at this height. On July 14, all tubes were measured and those needing adjustment were cut with a hack-saw. Note that 3 sites, (N20B #1, N04D #1, and N04D #2) are below the standardized height. Both N04D sites were cut in May 2004 due to bison damage.

2015: new soil moisture probe. InstroTek CPN 503 Elite Hydroprobe. The new machine only had 7 stops; the Troxler machines had 8. Also the probe is slightly longer on the Hydroprobe. Finally, measurements are given in g/cc; all readings are multiplied by 1000 to maintain the records in kg/m³.

		height	difference
R01A	1	15.5	7.5
	2	14	6
R20A	1	12	4
	2	12	4
004B	1	15.5	7.5
	2	13	5
020B	1	14	6
	2	8	0
R20B	1	8	0
	2	8	0

continued..		height	difference
001D	1	12	4
	2	23	15
R01B	1	13	5
	2	15	7
N20B	1	5	-3
	2	12	4
	3	8	0
	4	12	4
N04D	1	7	-1
	2	7	-1

2017: August 25 - bison damaged access tube #1. Top 0.5 inch has been cut off to repair the damage.

2018: April 12 - bison damage access tube #1 again. Top 0.25 inch has been cut off to repair the damage. In addition, the Konza staff made us 8 new spikes to help hold the barrier fence in place.

2018: August 9 – 2 cm of pipe removed from 0001d #2 to repair damage that was preventing the probe from fitting for readings.

2019: May 30 – Hole #1 at N4d. On May 30, techs were taking readings. The probe separated from the cable and dropped to the bottom of the hole. Hole #2 was 2m deep and the techs had detected 11cm of water in the bottom. We contacted Patrick O’Neal/KPBS and he tried a couple of ideas (magnet-all aluminum and a “snag”). He tried to pull the access pipe with a post puller and it would not budge. It also crimped the top of the pipe ending any hopes of getting the probe out via the pipe. The 4 techs began digging down around the pipe in hopes of wiggling it loose and pulling out the pipe and probe. They eventually hit rock/clay and could not make further progress. Plans were made with Patrick to bring in a backhoe on May 31.

2019: May 31 at 1:00 p.m. – KSU Radiation Safety was present; they requested being present at the time of removal to inspect the probe. Patrick began digging a trench alongside the hole that was dug on May 30; he dug down 2m. The end of the pipe was firmly stuck in clay so it was decided to employ a chain and pull the pipe up and out. The pipe came right out and the probe was inside. RSO Dr. Bridges declared the probe undamaged. Patrick pushed all the dirt back into the hole and drove over it a few times to pack it down.

2019: June 11 – A new hole was bored for N04d #1. A GeoProbe Soil Corer was used to dig the hole. Absolute depth is 201 cm. The pipe was cut to 8 cm above-ground height. The new location has been GPS-ed.

2019: June/July – A new cable was installed 190604. The technicians noticed that the probe was not able to go down as far as expected. On checking, all of the cable stoppers were off by ~16 cm. Readings for June 4, June 18, and July 2, 2019 were 16 cm too deep.

2021: October – the access pipe at n04d #1 has been pushed down and is now flush with the soil surface due to bison activity. Access pipes are set at 8cm above the soil surface.

2022: April – technician noticed that some of the cable stops were slipping during the 220406 readings. All of the cable stops have been measured for distance and tightened. All of the cable stops were adjusted. I have spoken to all previous users and none of them noticed any issues. Hopefully, this was a recent problem. (AKuhl)

25 cm	cable stop off by 5 cm too low (the readings done at ~30 cm)
50 cm	cable stop off by 2.5 cm too low
75 cm	cable stop off by 2.5 cm too low
100 cm	cable stop off by 5 cm too low
125 cm	cable stop off by 2.5 cm too high
150 cm	cable stop off by 2.5 cm too high
175 cm	cable stop off by 10 cm too high

2023: January – during the 2022 season, seven sites routinely showed a change in depth. The change in actual depths range from 1-10cm but the data sheet has been changed so that all readings are measurements where the probe is hanging freely and not touching the soil. Seven sites have been officially changed and we are watching 3 others. Data sheets are available.

		old depth	new
r01a	1	50	x=NO change
	2	75	50
r20a	1	75	x
	2	50	x

004b	1	100	x
	2	175	x
020b	1	100	x
	2	175	x
r20b	1	175	x
	2	125	x
001d	1	175	x
	2	175	150
r01b	1	150	125
	2	150	125
n20b	1	100	x
	2	175	x
	3	100	75
	4	100	x
n04d	1	175	150
	2	100	75

ASR01

Title: Short-Term Assessment of Effects of Burning on Infiltration, Runoff and Sediment and Nutrient Loss on Tallgrass prairie using rainfall simulation

Purpose: To determine the effects of burning on infiltration, overland flow, runoff and sediment and nutrient loss on tallgrass prairie using rainfall simulation

Date data commenced: 05/17/1989

Date data terminated: 08/26/1989

Location of Sampling Stations: Four plots at a single site on Konza

Variable Measured: Overland flow velocity, water application rate, runoff, hydrograph, water flow depth, sediment content, nitrogen and phosphorus content and percent ground cover

Methods:

Rainfall simulation and overland flow experiments were performed on four plots at a single site on Konza from May to August, 1989. Two plots were treated with late spring burn and two plots were left unburned. Five simulations were performed on burned plots and three simulations on unburned plots. Each simulation consisted of a “dry run” followed 24 hours later by a “wet run”. The dry run consisted of rainfall applied at an intensity of approximately 60 mm/hour. The wet run was the same as a dry run, except when the rainfall was complete, overland flow was applied directly at the top of the plots to simulate run off coming from upslope.

ASS01

Title: Suspended Sediments in Streams Impacted by Prescribed Burning, Grazing and Woody Vegetation Removal at Konza Prairie

Purpose: To determine effects of rotational burning and riparian vegetation removal on suspended solid concentrations in streams. Two sites are burned with a frequency of 2 (N02B) and 4 (N04D) years and grazed by bison. In 2011, N02B will have woody riparian vegetation removed along the entire stream length. The Shane Creek site (SHAN) is currently ungrazed and burned most years. In 2011 the treatment will be switched to grazing and burning of 1/3 of the watershed every year. The data include before and during-treatment sampling for both experiments.

Date data commenced: 05/06/2009

Date data terminated: ongoing

Location of Sampling Stations:

N02B: H-22 (grid location)

N04D: K-22

Shane Creek: T-9

Frequency of Sampling:

Samples are collected 2-3 times per week for duration of stream flow. Continuous optical turbidity measurements are made simultaneously. Study initiated May 6, 2009.

Variable Measured:

Mass per unit volume of total suspended solids and volatile solids is determined for three sites.

Field Methods:

One 4-liter sample is taken at each location. Great care is taken to not stir up the stream bed and sampler stands downstream from point where sample is taken or out of the stream. Date, time, stream temperature and stream height (N02B and N04D only) are recorded for each sample. Samples are refrigerated at 4°C for a minimum of 24-hours before further processing.

Laboratory Methods:

Samples are filtered onto prepared glass microfiber filters (pre combusted in a muffle furnace at 500°C, and weighed). Amount of sample varies from 50 mL to 4000+ mL depending on turbidity of sample, and volume filtered is recorded. Any remaining sample is discarded. Filters are oven dried at 100-105°C. Samples are weighed to the nearest 0.0001 g (total suspended solids= total mass- filter mass). Occasionally, a batch of filters will go through a second drying and weighing to check for accuracy. Re-wetting and re-drying of numerous samples yielded less than 1% change in measured mass, so re-wetting and drying is not done on every sample. Samples are then combusted in a muffle furnace at 500°C. Samples are weighed again to the nearest 0.0001 g (volatile solids= dry filter mass – combusted filter mass). Occasionally, a batch of filtered samples will go through a second drying following combustion to check for accurate accounting of water of hydration. Re-

wetting and re-drying of numerous samples yielded less than 1% change in measured weights. Filters are discarded after final weighing.

Form of Data Output:

ASS011 – data for watershed N02B

ASS012 – data for watershed N04D

ASS013 – data for watershed SHAN (SA, SB, SC, Shane Creek)

Summary of All Changes:

2018 March: We combined all three datasets into one by adding a 'watershed' column, so now the ASS011 data contains all three datasets for all watersheds.

AST01

Title: Soil temperature measured in burned, burn-clipped, and unburned plots at Konza Prairie

Purpose: Monitor soil temperature at various levels in burned, unburned, and burn-clipped conditions.

Date data commenced: 04/23/1987

Date data terminated: 10/01/1993

Location of Sampling Stations: 2 locations close to Headquarters (WA)

Frequency of Sampling: Hourly

Variable Measured:

Date, location, time, soil temperature (minimum, maximum, and mean)

Methods:

Soil temperature was measured using temperature probes and dataloggers at selected depths in small plots that were either burned annually, burned and clipped to remove aboveground biomass, or left unburned. Raw data was summarized into hourly readings and daily minimum, maximum, and mean temperatures.

Additional Information:

Only data from 1987 and 1988 are complete and error free for the entire time period. In 1989, the UB25 and B25 were dropped and a burned and clipped (to simulate grazing) were added. Variable number 10 became B2CL (burned and clipped with temperature probe at 2 cm) and variable 13 became B10CL (burned and clipped with temperature probe at 10 cm). Clipped is done at investigator description and in 1989 only two clips were done. In 1990, the plots were clipped 5th and 19th of June, 18th of July and 13 August. In 1991, the probes in the clipped plots malfunctioned and no data was collected in these two treatments. In 1992, no data was collected on clipped plots.

ASW01

Title: Stream water quality at the flumes on watersheds N04D and N02B and at the Shane Creek crossing on watershed SA at Konza Prairie

Purpose: To study water quality parameters of streams draining tallgrass prairie catchments, to estimate surface losses of solids including sediment, to allow estimation of whole stream metabolism, and to compare water quality characteristics of burn frequencies, grazing practices, and riparian cover. The sites samples represent bison grazed, patch burn grazed (following a pre-grazing period) and riparian vegetation removal.

Date data commenced: 10/23/2008

Date data terminated: 05/17/2010

Location of Sampling Stations:

Two sites are currently grazed by bison with a burn frequency of 2 (NO2B) and 4 (NO4D) years. The third site (SHAN) is currently ungrazed and has had a burn frequency of 1-2 years. In 2011, this site will undergo a new burning regime (patch burn on a 3-year rotation) and grazing (cattle) treatment. Yellow Springs Instruments (YSI) sondes are deployed at the deepest pool upstream of the flume at N02B (H-22 grid location) and N04D (K-22) and the crossing at SHAN (T-9) with the criteria that the pool is within 30 meters of the flume or crossing.

Frequency of Sampling and Variables Measured:

Water quality parameters are recorded every 10 minutes with YSI multiparameter water quality sondes model 6600 or 6920. Each record includes a date and time of the measurement and values for turbidity, dissolved oxygen, conductivity, temperature, and pH (see data set ASW01). These sondes use optical methods for turbidity and dissolved oxygen. Data are uploaded from the YSI sondes at approximately one to two week intervals. A near continuous record is kept, however missing records exist and are explained by the YSI sondes being removed for data download or the stream being dry or frozen.

Methods:

Water quality parameters are measured using Yellow Springs Instruments (YSI) multiparameter water quality sondes model 6600 or 6920. Turbidity and dissolved oxygen are measured using the YSI 6136 optical turbidity probe and the YSI 6150 ROX optical dissolved oxygen probe. Conductivity, temperature, and pH are measured with the YSI 6560 temperature and conductivity sensor.

The YSI sensors are calibrated at approximately the first of every month with the exception that the YSI 6150 ROX optical dissolved oxygen probe is calibrated every one to two weeks. Calibration methods and solutions are according to the YSI reference manual.

The YSI sondes are set to record unattended samples at 10 minute intervals. The YSI sondes are deployed inside a wire cage for protection from grazer traffic and cabled to a tree. Data logging is stopped using a handheld YSI 650MDS before the YSI sondes are retrieved. The YSI sondes are transported to the Bushnell Limnology lab where they are calibrated

and the data are uploaded as ASCII text files using EcoWatch software. Microsoft Excel is used to open the ASCII files and add comments. The files are reformatted as comma-separated values and written onto the network.

Form of Data Output:

Data are uploaded from the YSI sondes as ASCII text files at 10 minute intervals using EcoWatch software. Any comments are added and then data are stored as comma-separated values (.csv) files. The data from each site are stored as separate files on the LTER network.

ASW011—water quality data for watershed N02B;

ASW012—water quality data for watershed N04D;

ASW013—water quality data for watersheds SA, SB, and SC (Shane Creek).

AWE01

Title: Meteorological data from the Konza Prairie headquarters weather station

Purpose: Monitor meteorological parameters in tallgrass prairie on a long term basis.

Date data commenced: 04/22/1982

Date data terminated: ongoing

Location of Sampling Stations: Headquarters weather station (HQC).

Frequency of Sampling: Continuous sampling at headquarters weather station.

Variable Measured:

- 1) Air temperature at 2 m ($^{\circ}\text{C}$)
- 2) Relative humidity at 2 m (%)
- 3) Solar radiation down (0.3-3.0 μm , Wm^{-2})
- 4) Wind speed at 3 m (ms^{-1})
- 5) Wind direction at 3 m (degrees)
- 6) Precipitation (mm)
- 7) Soil temperature at 25 cm ($^{\circ}\text{C}$) (started June 1992)

Methods:

A Campbell Scientific (CR1000) data logger monitors air temperature, relative humidity, solar radiation, wind speed, soil temperature, and wind direction. Parameters are sampled once every 10 seconds. A microprocessor in the CR1000 manipulates the raw data and outputs the average air temperature, soil temperature, relative humidity, wind speed, solar radiation, and wind direction on 5-minute, hourly, and daily intervals. A separate Campbell Scientific CR800 data logger collects and stores precipitation data from an Ott Pluvio2 rain gauge. The CR1000 data is accessed every 5 minutes via wireless internet, and the CR800 is accessed every 15 minutes. SAS software is used to format and output data to AWE011 (hourly) and AWE012 (daily) final storage locations.

Missing data are signified with a blank or “.”.

Routine Maintenance:

Weather station bi-monthly checks include:

- Pyranometer check for level, dust accumulation, or other obstruction
- Relative humidity dust shield check
- Bearing check on anemometer and wind direction sensor

Biyearly maintenance includes:

- Calibration of li200x pyranometer
- Replace bearings and reed switch in anemometer and bearings in wind direction sensor

Summary of All Changes:

- Program execution interval was changed from 60 seconds to 10 on 7/17/2000. This change could significantly influence values reported for max wind speed. Caution should be used when comparing max wind speeds across this date.
- Hourly precipitation not precise and removed after 1/1/2000. All AWE01 ppt data before 3/19/2010 was collected via tipping bucket. APT01 data should be used for more accurate precipitation values.
- Soil temperature data collection began in June 1992, but data are unavailable from 2001 to August 12, 2008 and December 7, 2009 to May 21, 2010.
- Solar radiation variables were recalculated in March 2023 in order to standardize units that had been inconsistent across years.

Instrumentation:

Campbell LI200X pyranometer
Met One 024 wind direction sensor
Met One 014 wind speed sensory
Campbell HMP35C temperature and rh probe
Campbell 107 temperature probe.

AWT02

Title: Water temperature measured continuously in Konza Prairie streams

Purpose: To monitor water temperature continuously at each of four streamflow flumes. Such data is essential for proper interpretation of many stream phenomena and effects of global warming. Baseline data prior to implementing the burning or grazing protocols in Kings Creek south branch catchments will be used to assess the effects of these treatments on stream temperature. The relationship between hydrologic patterns and water temperature can also be examined.

Date data commenced: 04/10/1986

Date data terminated: 12/31/2000

Location of Sampling Stations:

Temperature is measured at the opening of the standpipe in the concrete V-flumes in N01B, N04D, N02B, and N20B.

Frequency of Sampling:

Temperature ($^{\circ}\text{C}$) values are recorded hourly. Data is dumped at approximately weekly to biweekly intervals (see data set ASD02).

Methods:

Thermocouple wire (copper-constantan) is connected to Channel 2 of the CR-21X data logger (Campbell Scientific Co.). Beginning April 1986 (July 1 for N20B), the CR-21X is programmed to include instructions for hourly recording of stream temperature (see data set ASD02). The CR-21X is internally calibrated for copper-constantan wire; recorded temperatures are verified by direct thermometer measurements at approximately weekly intervals (see data set AWT01). The computer program "streamtmp.com" (Pascal program on IBM PC) reads the raw data file as recorded by the CR-21X and generates the output data file.

Form of Data Output:

Files of the form "AWT021A.86", "AWT021B.86", etc., contain hourly temperature values for each flume for each year. Note that a value is recorded regardless of whether there is flow across the flume; thus, these files must be compared to corrected stream discharge (ASD02) values so that temperature data for no-flow conditions can be deleted.

Consumer Data

CBC01

Title: Weekly record of bird species observed on Konza Prairie

Purpose: To determine bird species phenology of occurrence.

Date data commenced: 01/01/1971

Date data terminated: 12/01/1996

Location of Sampling Stations:

Konza Prairie – entire area.

Frequency of Sampling:

Continuous.

Variable Measured:

Species presence.

Methods:

Direct observation.

Form of Data Output:

By species and by week, either present or not present, accumulated over five-year period. Separate file for every five-year period; e.g. all records up to 1984, 1985-1989, 1990-1996, etc.

CBC02

Title: Winter-spring survival and response of birds to variable climate using mist-net captures at Konza Prairie

Purpose: To (a) initiate a long-term survey of the non-breeding birds of the site, (b) understand the behavioral and physiological mechanisms that allow birds to cope with the unpredictable, variable, and often harsh conditions during winter months, and (c) provide a training platform for students. The collection of this dataset is fully integrated into the teaching of “Wild Bird Research” (an undergraduate hands-on research course in the Division of Biology) and less formal instruction in bird research methods for graduate students.

Date data commenced: 01/09/2016

Date data terminated: 12/30/2022

Methods:

Captures occurred typically 4 ~consecutive days/month in each of the following months: Dec, Jan, Feb, Mar, and Apr in most years. In some years, one or more months not sampled (e.g. COVID year). Each row in the nets table pertains to a single 12-m mist-net open on a single day and provides information on how long that net was open and available to capture birds. Each row in the capture table pertains to an individual captured on a certain day. Individual birds can repeat in this table if they were recaptured on the same or a different day. All birds were banded with a uniquely-numbered USFWS band. Most captures include data on age, sex, tarsus, wing chord, molt score, fat score, and mass. In many cases, a single feather was collected for collaboration with the Bird Genoscape Project. Some individuals were measured for body composition (fat mass, lean mass, and body water) using a mobile Quantitative Magnetic Resonance (QMR) machine. All birds were released at the location of capture or within 400 m of the capture net (central banding location in the middle of the watershed). Data are entered and stored in a MS Access database called LTERBandingData and backed up to the cloud and accessible by members of the Boyle lab. The queries that extract data files archived here are called Qy_LTERExport_NetHours and Qy_LTERExport_Captures

Research location: Watershed 20C. 40 fixed mist-net locations (permanent rebar) located along 10 lines bisecting habitat types within watershed. Primarily near the stream, through shrubby or treed areas, and extending into grassy areas.

There are two primary data files associated with this data package: CBC021 - NetHours.csv which provides information on the dates and capture effort for each date, and CBC022 - Captures.csv where all the bird data resides. They are related via the NetEventID field. Also provided is a list of Species data - CBC023 (links to captures via the SpeciesCode field and People (the Initials field corresponds to the Bander in the Captures table).

CBD01

Title: Date of occurrence for bird species observed on Konza Prairie

Purpose: Date of observation of all birds seen on Konza Prairie

Date data commenced: 01/01/1971

Date data terminated: 12/31/1992

Location of Sampling:

Konza Prairie – entire area.

Frequency of Sampling:

Continuous.

Variable Measured:

Species and date of observation.

Methods:

Direct observation.

Form of Data Output:

By species: yr-mo-day, in temporal sequence.

CBH01

Title: Konza Prairie Bison Herd Information

Purpose: To track herd structure and animal performance over time.

Date data commenced: 11/08/1994

Date data terminated: ongoing

Location of Sampling Stations:

Bison corral in HQB

Frequency of Sampling:

Weights are recorded and inventory taken each fall during the annual roundup.

Variable Measured:

Weight of each individual is recorded in pounds.

Bison Management:

The bison herd resides year-around in a 2433 acre fenced enclosure. Except during a few weeks preceding the annual roundup, the bison are allowed free access to all portions of the pasture. No regular supplemental feed is provided to the herd. Prairie hay is provided only when animals are corralled or during rare periods of deep snow cover. Roundup occurs annually in autumn. All animals are lured to the corral to be weighed and sorted. At this time the herd is culled to maintain a targeted herd size of 213AU. Cull animals are kept in the corral until sold. The remaining herd is released back to pasture.

Methods:

Upon arrival in the squeeze chute, each individual is restrained long enough to be identified, weighed, and worked. Each bison is equipped with an Allflex EID eartag. An EID reader sends the unique 15-digit EID number of each bison to the scale indicator. When the scale has stabilized and a valid weight is available, the scale operator pushes the “record” button on the indicator which sends the EID and weight to a laptop equipped with FileMaker Pro 13 software. Upon receiving input from the indicator, FileMaker records the weight of each bison.

Form of Data Output:

RECORD TYPE 1: Bison post-cull herd structure summary: raw data contain total number of male and female bison for each age class.

RECORD TYPE 2: Bison full herd weight information: raw data contain the ear tag number, sex, and weight of each individual.

RECORD TYPE 3: Bison maternal parentage: raw data contains the ear tag number of each calf and that of its mother.

Summary of All Changes:

Prior to 2013 bison were weighed on a Central City Scale Inc. livestock scale and weights were recorded in 2lb. increments, except for 2010 where 5lb. increments were used. In 2013 a Berlinic Mfg. Inc. hydraulic bison chute equipped with a TruTest XHS2 load cell system was installed, and weights were read on a TruText EziWeigh5 scale indicator. Weights recorded on the TruTest system are in 5lb. increments. Beginning in 2015, a TruTest EziWeigh7 scale indicator connected to a laptop equipped with FileMaker Pro 13 software has been used to electronically record bison weights. Prior to this weight were called out by the scale operator and handwritten by an assistant. 2013 CBH012 data is available by request only.

Quality Assurance:

Scale is calibrated and certified by WH Scale Co. annually before roundup.

Instrumentation:

Berlinic Manufacturing Inc. Hydraulic Squeeze Chute equipped with TruTest XHD2 load cell system and TruText EziWeigh7 Scale Indicator, TruTest XRP2 EID reader and TruTest large EID antenna, FileMaker Pro 13 software.

CBM01

Title: Plains bison movement patterns in an experimental heterogeneous landscape, Konza Prairie

Purpose: Track movements of female plains bison in space and time

Date data commenced: 2008

Date data terminated: ongoing

Location of Sampling:

All bison-grazed watersheds at Konza Prairie.

Frequency of Sampling:

Every 15 minutes to every two hours depending on individual and year.

Variable Measured:

Latitude and longitude (easting and northing).

Methods:

Collars deployed on female bison during autumn round-up.

Form of Data Output:

Date, time, and coordinates.

Instrumentation:

Telonics TGW-3700 CPS collars (Telonics, Mesa, AZ USA).

CBN01

Title: Records of breeding activities for birds on Konza

Purpose: To determine breeding bird species and phenology, nest site location by grid square, and record nest contents in terms of eggs and nestlings.

Date data commenced: 01/01/1971

Date data terminated: 12/31/1992

Location of Sampling:

Konza Prairie – entire area

Frequency of Sampling:

Continuous

Variable Measured:

Nest contents

Methods:

Direct observation

Form of Data Output:

By species, with grid square, nest contents, and miscellaneous remarks.

CBP01

Title: Variable distance line-transect sampling of bird population numbers in different habitats on Konza Prairie

Purpose: Estimate bird populations in tallgrass prairie, gallery forest, and riparian edge habitats.

Date data commenced: 05/27/1981

Date data terminated: 06/17/2009

Location of Sampling Stations:

4 year burn, grazed: N04D (0.961 km) + N04B (0.778 km) = 1.74 km

4 year burn, ungrazed: 004A (0.343 km) + 004B (0.902 km) = 1.25 km

1 year burn, grazed: N01B (L-6 = 0.546 km + L-10 = 1.091 km) = 1.63 km

1 year burn, ungrazed: 001D (0.914 km) + 001A (0.666 km) = 1.58 km

unburned, grazed: N20B = 1.49 km

unburned, ungrazed: 020B (0.545 km) + 020C (0.594 km) + 020D (0.636 km) = 1.78 km

gallery forest: lower King's Creek (0.882 km) + north fork (0.742 km) = 1.62 km

forest edge: upper Shane Creek = 1.30 km

Frequency of Sampling:

Censuses are conducted two times during the year: during the first two weeks of January as a measure of wintering populations, and during the first two weeks of June as a measure of breeding populations.

Variable Measured:

Individual birds by species (or by more general taxon if necessary, e.g. unidentified sparrow) seen or heard with an estimate of the perpendicular distance from the transect line. Sample data sheet (Figure 10.)

Methods:

General methods:

Bird populations are estimated using the variable distance transect method described by Burnham, Anderson and Laake (1980. Wildl. Monogr. 72). Censuses are conducted in each of the six LTER treatments (3 burn x 2 grazing) without regard to the two soil types since stratification of the sampling design according to soil type would limit transects to insufficient length and area of coverage. A single transect is composed of separate line segments from different plots of the same treatment that are simply added together. For example, if six dickcissels are counted in one transect in an annual burned, ungrazed plot, and 13 dickcissels are recorded on transect on another annual burned, ungrazed plot, the number of dickcissels recorded per transect in that treatment is 19. The only transect that is not segmented in this fashion is the forest edge transect. All other transects are composed of two or three separate segments.

Marking:

Each transect segment is marked at the beginning and the end with a galvanized steel conduit post into which a large marker flag has been inserted. For the grassland transects, these beginning and ending markers are short (total length about 45 cm) and the transect line is designated by yellow plastic marker flags placed in 50.5 cm conduits buried upright in the ground at 100 m intervals. For the forest transects, including the forest edge transect, the conduit posts are longer (ca. 90 cm) and are placed not only at the beginning and the end, but every 100 m along the transect route. These are further supplemented with yellow plastic marker flags to designate the transect line through dense vegetation.

Procedures:

The selection of a transect segment to be run on a given day is determined from a table of random numbers. No transect can be started later than three hours after sunrise regardless of the season. Since weather conditions affect the activity of birds and especially the ability of the observer to detect the birds, transect counts are not initiated if temperatures are below -15°F or wind speeds over 10 mph, or in moderately heavy snow or rain. Light rain, mists, and snow showers that do not greatly restrict visibility or impair the observer's use of binoculars are acceptable conditions for completing a transect count. Transect counts will begin at the marker designated on the map as the start. The most critical factor to keep in mind is that the observer must be progressing down-sun for most of the transect. The following protocol is followed:

- 1) Equipment needed: data sheet (Fig. 10), clipboard, pencils, and binoculars.
- 2) Proceed along the transect at a moderate rate, stopping every 20 meters or so to observe birds ahead and to either side of the transect line. Progress along the transect ought to be around 1 km / 45 minutes.
- 3) For all observations, estimate as exactly as possible (within 5 m) the perpendicular distance in meters of the birds from the transect line even though you will probably observe the bird at an acute angle relative to the transect line, and record this distance on the data sheet by species and by serially numbered observation.
- 4) It is essential that no bird directly on the transect line be missed.
- 5) If a bird is not seen until it flies, the observed perpendicular distance is from the point from which it flew.
- 6) Birds flying over the tract are not to be counted unless they land. Then the perpendicular distance to the transect line is that point.
- 7) An exception to the above rule applies to swallows, nighthawks, upland sandpipers, and harriers that are often observed over the plot but never come to rest. In these cases, estimate a distance from the transect line for each observation based on an "average" distance during the period of observation.
- 8) No bird can be counted twice. Disregard all subsequent sightings of a known individual after the first.
- 9) It is not necessary to differentiate between right and left sides of the transects. All observations are simply in terms of perpendicular distance from the transect line.
- 10) It is also not necessary to note at which point along the linear reach of the transect a particular observation is made.
- 11) All birds within the treatment are to be counted. There is no fixed width. Birds beyond the boundaries of the treatment are not to be counted. There are regions of transects that come relatively close to a treatment boundary (e.g., the south end of the transect in D-1), so be alert for the location of mowed strips between treatments.

- 12) It would facilitate the estimation of distances from the transect if fixed objects, such as trees, shrubs and rock outcrops along the transect route are actually measured in terms of their perpendicular distance from the transect. Since some of these are used as perches, they give an exact measure of distance. They will also serve to reinforce the observer's ability to estimate perpendicular distance as he/she progresses along the transect.

Form of Data Output:

Estimates of absolute densities from this method require the enumeration of at least 40 observations per transect. Observations can be grouped by habitat type within each treatment (e.g., grassland, Cornus thickets, stream bottoms, etc.) or they could be grouped by guild to attain the 40 observations minimum and thus permit comparisons in terms of absolute densities between treatments, seasons, years, and with similar data in other locations. Since the method of data collection on transects is similar and since each transect is of similar length, relative density comparisons in terms of birds/kilometer or relative frequencies can be made between treatments, seasons, and years.

Summary of All Changes Up to 1993:

1981: Transects were as presently located except no transect in N20B and there were transects in

N20C (now N01A), N20D (now part of N01B), N01C (now N02B), N01D (now part of N01B), and N04C (now N04B).

1982: Transects in N20C (N01A) and N01C (N02B) were dropped, N20D was maintained in what is now N01B. N01D became the second transect in what is now N01B, and N04C transect was maintained in what is now N04B. N20B was added.

1990: 004d became SA and transect was dropped.

Comments: Miscellaneous notes on the natural history of the bird sighting Time: If obsnum=1, the start and end times for the bird survey transect. All surveys were conducted in morning hours in the Central Timezone (CT). Time could be either Central Standard Time (CST) or Central Daylight Time (CDT) depending on the month of survey. In some cases, the end time was not recorded for the survey (End=????), but duration was set to be the average survey time for that transect in a given season. Duration: If obsnum=1, the duration of the bird survey transect in minutes. Observer: If obsnum=1, the name of the observer conducting the bird survey. Bird survey transects were conducted by four different observers over the 29-year period from 1981 to 2009: Elmer J. Finck (ca. 1981-1989, n = 430 surveys), John L. Zimmerman (ca. 1990-1997, n = 293 surveys), Christopher C. Smith (1998-2001, n = 105 surveys), and Brett K. Sandercock (2002-2009, n = 240 surveys).
Metadata revised: 06/26/2016

CBS01

Title: Capture records of (mainly) Grasshopper Sparrows on Konza Prairie

Purpose: To record and band Grasshopper Sparrows on Konza Prairie.

Date data commenced: April 2013

Date data terminated: ongoing

Variable Measured:

Species, age, sex, capture date, location of capture, head-bill, tarsus, wind chord, molt score, fat score, and mass.

Methods:

This dataset includes captures of mainly Grasshopper Sparrows (GRSP), but includes other songbirds. Each row pertains to an individual captured on a certain day. Individuals can repeat. Most captures include data on age, sex, head-bill, tarsus, wind chord, molt score, fat score, and mass. In many cases, a single feather was collected from each Grasshopper Sparrow for isotopic analyses, and when available, results of those data are included. Some individuals were measured for body composition (fat mass, lean mass, and body water) using a mobile Quantitative Magnetic Resonance (QMR) machine. Most individuals were bled in the field within 5 min of capture. The blood was chilled, centrifuged the same day, and plasma stored frozen for analyses of metabolite concentrations. Red blood cells were stored in lysis buffer for genotyping. All birds were banded with a USFWS band and adults were individually marked using a unique combination of 3 plastic colored leg bands. Birds captured as independent young or nestlings banded prior to fledge were only marked with the USFWS bands. All birds were released at the location of capture.

Species Code:

<u>Species Code</u>	<u>Common Name</u>	<u>Scientific Name</u>
BHCO	Brown-headed Cowbird	Molothrus ater
GRSP	Grasshopper Sparrow	Ammodramus savannarum
HESP	Henslow Sparrow	Ammodramus henslowii

Color Band Color Abbreviations:

A	Gray
B	Light Blue
D	Dark Blue
G	Green
K	Black
O	Orange
P	Pink
R	Red
S	Silver
W	White
Y	Yellow

Age:

NG Nestling
HY Hatch Year
AHY After Hatch Year
SY Second Year
ASY After Second Year
TY Third Year
ATY After Third Year
U Unknown

How aged or sexed:

Plumage Young (hatch-year) birds have distinct plumage. Following their first year, GRSP cannot be sexed or aged by plumage.
CP Cloacal Protuberance present – indicates male in breeding condition
BP Brood Patch present – if >0.5, indicates female in breeding condition (males only lose a few belly feathers)
OnNest Nestlings found in nest = known age. Birds flushed from nest sexed as females
Song Males observed singing prior to capture (females don't sing)
Display Males observed displaying prior to capture (females don't display)
Molecular Molecularly sexed post-hoc
Ossification Young (< 4 months) birds have incomplete ossification
Recap If a bird was captured in a previous season, we can age precisely (if HY or NG at time for first capture), or known minimum age (if captured as AHY)

Sex:

M Male
F Female
U Unknown

CP:

0 No evidence of swelling
1 Very slight thickening
2 Still longer than wide, but noticeably bulging
3 Resembling the drawing in the front of Pyle guide
4 Size of an unripe blueberry
5 Size and color of a ripe blueberry

BP:

1 Smooth feathers are dropped and some vascularization is evident, but most of the area is rather smooth and dark red.
2 Vascularization is evident, some wrinkles are present, and some fluid is present under the skin, giving the area a pale, opaque, pinkish color.
3 Vascularization is at the maximum extent of the brood patch; the brood patch is thickly wrinkled, and much fluid is present under the skin

- 4 Wrinkled, vascularization and fluid are mostly gone, skin retains many think, dry, contracted wrinkles
- 5 Molting with no vascularization or fluid, most wrinkles are gone, and pinfeathers present only on breast with no other flight feather or body molt occurring

Molt:

- 0 No molt
- 1 Some pin feathers, adventitious flight feather molt, or very beginning stages of complete molt (i.e., dropped feathers but no new feathers grown in)
- 2 Moderate molt. Multiple feather tracts and/or flight feathers or retricies
- 3 Most tracts in molt including flight feathers and body

Fat:

- 0 No fat visible in furculum
- 1 A light covering or partial covering of fat on the inside of the furculum
- 2 >10% full and <~35% full
- 3 Roughly half full of fat
- 4 Furculum ~75% full, fat typically extending out of furcular area at top and some visible fat in wing pits and lower belly
- 5 Furculum ~full-slightly bulging. Obvious fat reserves elsewhere on the body
- 6 Furculum very bulging. Extensive fat reserves everywhere

Observers:

- AB W. Alice Boyle
- AJH Alex Henry
- AJM Andrew Mayer
- ANB Allison Bays
- BNP Blair Pfeifer
- BV Bram Verheijen
- CES Chelsea Sink
- CKP Chyna Kaling Pei
- DCA Dakota C Allen
- DDH Destiney Hett
- DJS Dylan Smith
- EJW Emily Williams
- GW Virginia Winder
- HCM Henry Castro-Miller
- HN Hunter Nedland
- HRL Heather Lerner
- JLG Joanna Gresham
- JMG Jackie Gehrt
- JMS Joseph Schmidt
- KB Katharina Bremser
- KEG Keil Garey
- KET Katelyn E Thompson
- KLK Kristin Kersten

KMS Katy M. Silber
MDR Miriam Reynaldo
MKW Mary Kate Wilcox
MLG Michaela Gustafson
MW Mariel Winnerman
NAB Natasha A Bergevine
RCD Ryan Donnelly
SKW Sarah Winnicki
SLD Sarah Demadura
SVR Suzy Replogle Curnutt

CBS02

Title: Nests of Grasshopper Sparrows on Konza Prairie

Purpose: To count and describe Grasshopper Sparrow nests on Konza Prairie

Date data commenced: May 2014

Date data terminated: ongoing

Variable Measured:

Location, date found, egg measurements, bird sex, stage of nest, inferred fate of nest

Methods:

This data set contains data describing Grasshopper Sparrow nests. These nests were primarily found by rope dragging but also on surveys (see RI Survey Data Set), flushing birds during other activities, and via behavioral observations. We described nest contents and monitored nest fate via visits every 2-3 day and by placing an iButton placed in the center of the nest flush with the bottom of the nest cup and comparing temperature traces to a second iButton placed outside of the nest to determine the timing of nest failure and other metrics of incubation/brooding behavior. We compiled counts of partial egg loss, partial brood loss, and estimated causes of nest failure, comparing the timing of these events with KNZ-collected meteorological data to determine the temporal association between rainstorms and nest abandonment.

Codes Used:

GRSP	Grasshopper Sparrow (<i>Ammodramus savannarum</i>)
BHCO	Brown-Headed Cowbird (<i>Molothrus ater</i>)
NOAA	National Oceanic and Atmospheric Administration

Color Band Color Abbreviations:

A	Gray
B	Light Blue
D	Dark Blue
G	Green
K	Black
O	Orange
P	Pink
R	Red
S	Silver
W	White
Y	Yellow

Observers:

AB	W. Alice Boyle
ADT	Alaina Thomas
AJH	Alex Henry
AMC	Amanda Charpinel

BJR Breyana Ramsey
BV Bram Verheijen
CES Chelsea Sink
CRW Caitie Weichmann
DDH Destiney Hett
DJS Dylan Smith
EJH Emily Hudson
EJW Emily Williams
HN Hunter Nedland
JMG Jackie Gehrt
KRW Kyle Wait
LTA Lauren Angermeyer
MLG Michaela Gustafson
SKW Sarah Winnicki
SVR Suzy Replogle Curnutt

Methods Found:

BO Behavioral Observation
RW Random Walking
RD Rope Dragging
OT Other
UN Unknown

Stage Found:

BU Building
LAY Laying
IB Incubating
NG Nestlings
FL Fledged/Fledglings

Inferred Fate:

SU Fledged =1 GRSP
SC Fledged =1 GRSP and =1 BHCO
CO Fledged only BHCO or abandoned due to cowbird parasitism
PR Nest contents eaten
AB Abandoned for no apparent reason
TR Trampled by livestock
WE Nest flooded, nestlings died of exposure
HU Suspected human-caused abandonment or destruction

CBS03

Title: Grasshopper sparrow surveys: density, reproductive index, and locations of marked individuals on Konza Prairie

Purpose: To survey Grasshopper Sparrows on Konza Prairie and Rannell's Preserve

Date data commenced: May 2013

Date data terminated: ongoing

Location of Sampling Stations:

14 watershed units on Konza and 2 adjoining units on Rannell's Preserve

Frequency of Sampling: Every ~7-10 days

Variable Measured:

Date, location weather, number of territorial males

Methods:

Data on the location, identity, and reproductive index (Vickery, 1992 #5253) of Grasshopper Sparrows within 10-ha plots on 14 watershed units on Konza and on 2 adjoining units on the Rannell's Preserve. Each plot was surveyed every ~7-10 days. These surveys documented individual sparrow locations, and are used to calculate dispersal distances and territory densities.

Codes Used:

Observers:

AB W. Alice Boyle
AJH Alex Henry
AJM Andrew Mayer
ANB Allison Bays
BNP Blair Pfeifer
BV Bram Verheijen
CES Chelsea Sink
CKP Chyna Pei
DDH Destiney Hett
DJS Dylan Smith
EJW Emily Williams
GW Virginia Winder
HCM Henry Castro-Miller
HN Hunter Nedland
HRL Heather Lerner
JLG Joanna Gresham
JMG Jackie Gehrt
JMS Joseph Schmidt

KB Katharina Bremser
 KEG Keil E Garey
 KET Katelyn E Thompson
 KMS Katy M Silber
 MDR Miriam Reynaldo
 MKW Mary Kate Wilcox
 MLG Michaela Gustafson
 MW Mariel Winnerman
 NAB Natasha A Bergevine
 RCD Ryan Donnelly
 SKW Sarah Winnicki
 SLD Sarah Demadura
 SVR Suzy Replogle Curnutt

Wind:

0	Calm	Calm, smoke rises vertically
1	Light Air	Smoke drift indicates wind direction
2	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	Moderate Breeze	Dust, leaves, and loose paper lifted, small tree branches move
5	Fresh Breeze	Small trees in leaf begin to sway
6	Strong Breeze	Larger tree branches moving, whistling in wires
7	Near Gale	Whole trees moving, resistance felt walking against wind

Precipitation:

None, mist, drizzle, light rain, heavy rain, snow, hail

Reproductive Index:

1	Territorial Buzz song
1.5	Courtship Alternate song
2	Paired Two birds, no fight
3	Nest Building/Incubating Carry Grass, flush, close, chips
4	Nestlings Carry food; chips, little song
5	Fledglings

Species Code:

Species Code	Common Name	Scientific Name
GRSP	Grasshopper Sparrow	<i>Ammodramus savannarum</i>
DICK	Dickcissel	<i>Spiza Americana</i>
EAME	Eastern Meadowlark	<i>Sturnella magna</i>

Color Band Color Abbreviations:

A	Gray
B	Light Blue
D	Dark Blue
G	Green
K	Black
O	Orange
P	Pink
R	Red
S	Silver
W	White
Y	Yellow

Vickery, P. D., M. L. Hunter, and J. V. Wells (1992). Use of a new reproductive index to evaluate relationship between habitat quality and breeding success. *Auk* 109:697-705.

CBS04

Title: Sweep sample data: prey estimates for Grasshopper Sparrows on Konza Prairie

Date data commenced: May 1, 2014

Date data terminated: December 31, 2020

Location of Sampling Stations: 3 locations on each of the focal watersheds

Frequency of Sampling: Monthly in May, June and July

Variable Measured:

Information about the sampling events, sample wet mass, edible mass, number of individuals in each of a series of size categories, total N, and mass.

Methods:

This data set includes data on the contents of sweep samples. We collected sweeps in 2014 monthly in May, June, and July in 3 locations on each of the focal watersheds. Sweeps were X m long and centered at veg points. Data consist of information about the sampling events, and sample wet mass, edible mass (combined mass of selected orders listed below). Additionally, the dataset includes the number of individuals in each of a series of size categories, total N, and mass (in grams) of the following groups: Tettigoniidae, Acrididae, other Orthoptera, Gryllidae, Odonata, Ephemeroptera, Coleoptera, Hymenoptera, Lepidoptera, Arachnida, Hemiptera, Neuroptera, Diptera, Phasmatidae, Mantidae, and “other”.

Codes Used:

Sampled by and Processed by:

ADT Alaina Thomas
AJH Alex Henry
ALL Ashley Lysaught
AMC Amanda Charpinel
ASS Amie Sommers
BJR Breyana Ramsey
CES Chelsea Sink
CRW Caitie Weichmann
DJS Dylan Smith
EGS Emily Samuel
EJW Emily Williams
ENS Elizabeth Sroor
HN Hunter Nedland
JMG Jackie Gehrt
JMM Jerusha Matthews
JNB Jordann Baker

KMS Katy Silber
LAG Logan Green
LVO Logan VanOverschelde
MKW Mary Jane Wilcox
MMS Meredith Schmidt
MDR Miriam Reynaldo
SVR Suzy Replogle Curnutt
VTN Valerie Nyguyen

Wind:

0	Calm	Calm, smoke rises vertically
1	Light Air	Smoke drift indicates wind direction
2	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	Moderate Breeze	Dust, leaves, and loose paper lifted, small tree branches move
5	Fresh Breeze	Small trees in leaf begin to sway
6	Strong Breeze	Larger tree branches moving, whistling in wires
7	Near Gale	Whole trees moving, resistance felt walking against wind

Taxonomy Group Size Class:

- 1 – (<5 mm)
- 2 – (5~25 mm)
- 3 – (15~25 mm)
- 4 – (25~35 mm)
- 5 – (35~45 mm)
- 6 – (>45 mm)

CBS05

Title: Estimates of vegetation structure and composition collected on Konza Prairie watersheds and on the nearby Rannell's Preserve

Date data commenced: May 2014

Date data terminated: ongoing

Location of Sampling Stations: Konza watersheds and nearby Rannell's Preserve

Frequency of Sampling: ~Monthly

Methods:

Data set includes estimates of vegetation structure and composition collected during ~monthly sampling events on Konza Prairie watersheds and on the nearby Rannell's Preserve. Vegetation data were collected from three randomly-selected locations were chosen randomly on each watershed; two from outside the 10-ha plot (see project abstract) and one inside the plot. We sampled vegetation on each watershed once a month, during May, June, and July. Additional vegetation data were collected from Grasshopper Sparrow nest sites within ~3 days of nests failing. We used 5 sets of Daubenmire frame measures to determine percent cover of major plant functional groups (at the center of the plot and 5 m from center at the 4 cardinal directions). We estimated visual obstruction by placing a Robel Pole in the middle, and 5 m from the middle of the plot in each of the 4 cardinal directions. For each pole placement, we stood 4 m away with eye 1 m above the ground in each of 4 directions, and counting the highest 5-cm segment not completely obscured by vegetation. At nests, we also estimated the slope and aspect in the center of each plot.

Codes Used:

Observers:

ADC Austin Carter
ADT Alaina Thomas
AJH Alex Henry
AJM Andrew Mayer
ALW Aja L Wong
AMC Amanda Charpinel
ASS Amie Sommers
BJR Breyana Ramsey
BRR Braiam R Rosado
CES Chelsea Sink
CRW Caitie Weichmann
DBW Danny Wells
DCA Dakota C Allen
DCS Darrien C Savage
DHH Destiney Hett
DJS Dylan Smith
ECB Emma Blackwood

EJW Emily Williams
ENS (Elizabeth) Liz N. Sroor
ETH Edwin T Harris
HCM Henry Castro-Miller
HN Hunter Nedland
JLG Joanna Gresham
JMG Jackie Gehrt
JMS Joseph Schmidt
JN Jessica Nyguyen
KAU Kailyn Underwood
KET Katelyn E Thompson
KJP Kevin J Perozeni
KMS Katy M Silber
LTA Lauren Angermeyer
MDR Miriam Reynaldo
MKW Mary Kate Wilcox
MLG Michaela Gustafson
MRB Maddie R. Bell
MW Mariel Winnerman
NAB Natasha A Bergevine
NAW Nathalie Wright
RCD Ryan Donnelly
SKW Sarah Winnicki
SVR Suzy Replogle Curnutt
VRG Victoria Gaa

Veg Plot Location:

Center	Center of point
N	North of point
E	East of point
S	South of point
W	West of point

CBS06

Title: Line transects surveys of breeding birds throughout Konza Prairie

Purpose: Like CPB01 and PBG051, this dataset includes records of bird species based on line transect sampling. These surveys re-initiate most of the original KNZ transects surveyed from 1981-2009 (initiated by Zimmerma), continue the two focal 300-m transects conducted from 2011-2016 by Sandercock on watersheds C3A, C3B, C3C, C1A, and 1D, (but not the peripheral segments which have been dropped), and adds two new 300-m transects to additional watersheds with the goals of (i) replicating all surveyed treatments at the watershed level, (ii) adequately sampling the grassland habitats present on Konza as of 2017, (iii) capturing transitions in bird community in response to woody encroachment and fire reversal treatments. The goals are to document and quantify long-term changes in the population sizes of breeding birds at Konza prairie by obtaining a standardized measure of annual breeding bird abundance at the site level and individual watershed or treatment level.

Date data commenced: 01/02/2017

Date data terminated: 12/30/2022

Methods:

Original transects varied from ~250 m to ~1.5 km, typically bisected watersheds roughly in the direction of the longest axis. Although roughly linear, lines sometimes bent or wiggled. Original conduit posts are probably gone, but Brett Sandercock walked all transect lines and marked them with a GPS unit in 2011 or 2012. PBG and new transects were/are never marked physically on the ground. Apparently, no limits to the detections of birds that observers recorded were placed relative to distances to watershed boundaries or other transect lines. However, previously, observers made an attempt not count birds detected outside of watershed boundaries. When possible, new transects do not come closer than 100 m from a watershed boundary nor closer than 100 m perpendicular to other transects. When located ~end-to-end, transect lines are sometimes closer, but this should not pose a problem for double-counting birds (see below). New transects were located using GIS and aerial imagery to bisect geographic gradients within watershed and present a representative sample of the habitat within watersheds.

Each of the older CPB01 transects have been divided into 300 m units, and all new watersheds that are now surveyed under this protocol are exactly 300 m long. Where possible, there are at least 2, 300-m lines in each watershed that do not intersect one other and do bisect major topographic axes of the unit. These protocols try to preserve as much of those originally documented in the Konza data catalogue of 1980s as possible. Changes to the protocols reflect (a) updated equipment, (b) the desirability of obtaining spatial data for birds observed, and (c) lack of detail regarding environmental conditions under which summer bird surveys should be conducted. Regarding (c), I have incorporated rules of thumb communicated to me by Brett Sandercock as conducted on the patch-burn-grazing surveys in 2011-2016 and noted any changes to protocols that I am aware of (and the reason for those changes).

One observer counts birds on each transect once per year (typically Boyle, but occasionally, other skilled observers). They start counting birds ~30 min before sunrise and attempt to not begin a transect line after about 10:00 am. On a single morning, it is possible to survey 4-6, 300-m lines or roughly 2-3 km total (for irregular-length lines) in a single morning, providing that transects are not located too far away from one another. Previously, observers selected transects using a random procedure. Due to the large number of transects now being surveyed, logistical/time constraints now dictate which surveys are conducted in a single morning. Transects surveyed in a single morning minimize between-transect travel times, attempt to avoid walking into the sun, and do not survey birds on two watersheds of the same treatment on a single morning.

If possible, all transects are surveyed in the month of June. Originally, the handbook indicated that they should be run during the first 2 weeks of June. Actual survey dates range from 27-May to 28-Jun. Previous protocols indicated that observers should not start a transect when wind speed exceeded 10 mph (16 kph or no higher than Beaufort 3, see appendix 4). PBG051 did not have any explicit wind or temperature restrictions. From 2017 onward, surveys occur when wind conditions are up to and including Beaufort 4 but not higher. Also, because detection of many grassland birds is strongly affected by temperature, they are not initiated when the temperature is lower than 10°C or higher than ~26°C. Mist, drizzle, cloud cover is fine, but not fog or any precipitation more than a very light rain. Observers now note weather conditions at start and end of survey period using weather data from Manhattan.

Observers record information about survey events (observer, date, watershed, transect #, start and end time, weather at beginning and end) then a record of all birds detected. Observers note species using standard American Ornithological Society 4-letter codes, N individuals when birds are simultaneously detected in a group, not audio detection only, flyovers (i.e. birds that do not touch down, forage over, or otherwise interact with the vegetation or ground), birds off-watershed, or beyond line, and sex of birds if known. Previously, the distance along the line was not noted, and only the perpendicular distance of the bird from the line was noted. To enable mapping of birds on the landscape, from 2017 on, observers record (a) their distance along the line, (b) the actual distance from the observer to the bird, (measured using a range-finder for at least 30% of birds, and estimated by eye when accuracy by comparing rangefinder and estimates are within ~5 m) and (c) the angle from the observer to the bird measured using a compass. Observers start by noting all birds detectable at the start of their line, then walk slowly, stopping as needed to record all birds detected as you go, pausing every 30 m or so to look and listen. The pace is was formerly noted as being ~1 km/45 min (PBG051) but due to recording angles and locations, a typical 300 m transect takes ~30 minutes.

The observer records the locations where they first detected the bird for any individual or group. For true flyovers, record the closest location to the transect line that the individual or group passed over. Where an aerial insectivore (e.g., nighthawk, swallow) is flying over the prairie low and likely foraging, do not count that as a flyover. If you detect an upland sandpiper way above a plot, try to determine where it is coming down. If it appears to be circling a territory on the watershed, count it NOT as a fly over. The point is to be able to exclude observations of birds not interacting with the local habitat with this data field.

There is no limit on the distances at which you can record detections. It is very important

NOT to double-count individual birds within or between transects! Some birds may be detected beyond the transect line (i.e. a perpendicular line drawn from the bird's location to the angle of the line would bisect somewhere beyond the endpoint), but observers attempt to only record birds detected at unlimited distances in an imaginary rectangle extending to the L and R of each line. Previous protocols did not include birds beyond the line, so to facilitate comparisons to old data, only use the "beyond line" checkbox if you can't help recording a rarer bird past the end of the line (backwards or forwards) or if you note a bird and then subsequently realize it is beyond bounds.

CFC01

Title: Kings Creek long-term fish and crayfish community sampling at Konza Prairie

Purpose: Research on intact tallgrass prairie can provide information for conservation and management by describing conditions under which native species evolved. Our study aim is to quantify the distribution, density, abundance and size structure of fishes in protected tallgrass prairie stream watersheds in Kings Creek and identify ecological factors that influence fish species or community structure.

Date data commenced: 05/16/1995

Date data terminated: ongoing

Location of Sampling Stations: Kings Creek

Frequency of Sampling:

Fishes were sampled seasonally from 1995 through 2007. From 2007 to present sites are sampled three times annually in May, August and November.

Variable Measured:

Each fish is identified to species and measured for total length (mm). We also measure flow velocity (m/s), canopy cover (%), substrate size (1-8), channel width (m), depth (m), sample reach length (m), and in-stream cover (m²).

Methods:

METHODS (field): Fishes were sampled with single-pass backpack electrofishing with two netters in May, August and November 1-3 pools and 1-3 riffles at each site (depending on reach stream structure). In each pool and riffle, discharge, substrate, depth, velocity, width and percent canopy cover were measured along 3 transects. Depth (m), current velocity (m/s taken at 60% depth, using a Marsh-McBirney Model 2000 flowmeter) and substrate size-class (based on modified Wentworth scale; Cummins, 1962) were quantified at 5 points along the width of each transect. Substrate size classes were numerically scored [1 (clay/bedrock), 2 (silt), 3 (sand), 4 (gravel), 5 (pebble), 6 (cobble) and 7 (boulder)] to give an average size for each habitat sampled. Percent canopy cover was estimated by averaging the densiometer readings at the center of each of the three transects per pool. In-stream cover throughout the pool was characterized as log complex, aquatic vegetation, undercut bank, log, brush pile, bank grass or root wads and length and width were measured.

CFP01

Title: Fish population on selected watersheds at Konza Prairie

Purpose: This data set is a species list of the fish population on selected watersheds.

Date data commenced: 05/16/1995

Date data terminated: 11/20/2018

Location of Sampling Stations: 6 sites in the Kings Creek watershed

Frequency of Sampling: Seasonally

Field Methods:

Fishes were collected by habitat (pool or riffle) at 6 sites in the Kings Creek watershed with a single-pass electrofishing survey with one person operating the electrofisher and two people dipnetting.

Notes:

Starting 2019, we stopped to process this data, since this dataset was derived from CFC011 (All fish and crayfish population length data). For more information, please check CFC01 project at here: <https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-knz.130.8>

CGP01

Title: Gall-insect densities on selected plant species in watersheds with different fire frequencies

Purpose: To estimate population densities of four common gall-forming insects in the Konza Prairie LTER watersheds. Gall insect populations are studied because they represent an important and diverse guild of consumers and their numbers can be assessed directly by surveying their host plants for the presence of stem galls.

Date data commenced: 10/01/1988

Date data terminated: 12/30/1996

Location of Sampling Stations:

Sampling is done in watersheds 001A, 001B, 001C, 001D, 004A, 004B, 004C, 004D, 004F, 004H, 010A, 010B, 010C, SuA, SuB, 020A, 020B, 020C and 020D.

Frequency of Sampling:

Once per year. Because a gall provides a stationary record of the presence of the insect that remains as long as the stem remains intact, sampling time is flexible and can be done anytime between August and November. If sampling is delayed onto the winter months, many of the stems may senesce and lodge resulting in increased sampling time and effort required.

Variable Measured:

The frequencies of four different gall types on three host plants are measured (Fig. 11). The frequency of round galls of *Eurosta solidaginis* (Diptera: Tephritidae) and elliptical galls of *Gnorimoshema gallaesolidaginus* (Lepidoptera: Gelechiidae) are measured on populations of *Solidago canadensis* (Canada goldenrod: Asteraceae). Frequencies of stem galls of *Periploca ceanothiella* (Lepidoptera: Cosmopterigidae) are measured on *Ceanothus herbaceous* (Inland ceanothus or New Jersey Tea: Rhamnaceae). The frequency of galls of *Eutreta sparsa* are measured on *Vernonia baldwinii* (Inland ironweed: Asteraceae).

Methods:

For goldenrod, a random walk is initiated in the lowland area of the watershed and the first 20 goldenrod clones encountered are sampled. Both gall types are censused by establishing a random transect across each clone and sampling 200 stems. The number of galls of each type per 100 stems is recorded. If the clone contains less than 100 stems, then the number of stems sampled and the number of each type of gall is recorded.

Ceanothus is common in bands along the upper rocky slopes of each watershed. Sampling consists of walking a random transect across the *Ceanothus* population and establishing a sampling point at every three paces. At each sampling point 100 continuous branches are sampled and the frequency of branches galled is recorded. This procedure is continued for 10 sampling points along the transect.

Ironweed occurs primarily in the shallow soil uplands on Konza Prairie. Four random transects are walked through the upland area of the watershed. Along each transect, the

first 50 stems encountered are censused and the number of ironweed basal galls (*Eutreta sparsa*) are recorded. Unlike the other stem galls, the ironweed gall occurs at the stem base and is not easily seen. Sampling is accomplished by sliding the forefinger and thumb down the stem to the base where root branching occurs to verify the swollen tissue at the base of the lowest stem node.

CGR01

Title: Sweep Sampling of Grasshoppers on Konza Prairie LTER watersheds in 1981 only

Purpose: Monitor yearly changes in species composition and abundance of grasshopper assemblages.

Date data commenced: 04/01/1981

Date data terminated: 12/01/1981

Location of Sampling Stations:

One site each on Florence and Tully soil on each of the six LTER watersheds (1981)

Frequency of Sampling:

180 sweeps at each site in June, August, and September (18 sets of 10 sweeps)

Variable Measured: Location, soil type, species

Methods:

Sweeps were taken with canvas beating nets 38 cm in diameters; 18 sets of 10 sweeps each were taken at each site. A sweep was taken at each step by traversing an arc of 180 degrees with the net through the top layer of vegetation. After 10 such sweeps, the contents of the net were emptied into plastic bags. These samples were frozen until grasshoppers were removed and identified.

CGR02

Title: Sweep Sampling of Grasshoppers on Konza Prairie LTER watersheds (1982-present)

Purpose: Long-term monitoring of dynamics of species composition and abundances in grasshopper assemblages associated with varying frequency of fire.

Date data commenced: 04/01/1982

Date data terminated: ongoing

Location of Sampling Stations:

Two replicate sites per treatment. All sites are on upland (Florence) soils. In order from east to west:

Ungrazed

002D A: grid V-26

B: U-24

001D A: T-24

B: R-27

0SuB A: R-27

B: Q-28

004F A: Q-28

B: P-28

020B A: O-28

B: N-28

002C A: L-29

B: L-31

0SpB A: K-29

B: J-28

004B A: H-28

B: F-27

Grazed

N20B A: S-24

B: P-22

N01B A: S-25

B: P-23

N04D A: L-28

B: K-28

N04A A: G-25

B: F-26

N01A A: G-19

B: G-21

N20A A: G-20

B: E-19

Frequency of Sampling:

All sites are sampled twice (approximately 1 week apart) in late July to early August.

Variable Measured:

Number of individuals (categorized by instar) for individual grasshopper species.

Methods:

Sampling is done by sweeping with canvas beating nets 38 cm in diameter. A sample of 200 sweeps (ten sets of 20 sweeps each) is taken at each site on each occasion. A sweep is taken at each step by traversing an arc of 180° with the net through the top layer of vegetation. After 20 such sweeps, the contents of the net are emptied into plastic bags. Air is squeezed out and samples are kept on ice until they can be frozen. Samples will be sorted and identified to species and instar. At this time, all “other” insects are also kept.

All samples are taken between 1000 and 1500 hours on clear, calm warm days: cloud cover should be less than 50%, winds less than 24km/hr (15 mph), and ambient air temperature should be 25-40°C.

Sweeping effectiveness varies with site and season on Konza Prairie (e.g. sweeping is less effective on unburned prairie than on burned prairie). However, sweeping does provide good estimates of relative abundances of individual species present at any one place and time on both burned and unburned prairie. For more information, consult: Evans, E. W., R. A. Rogers, and D. J. Opfermann. 1983. Sampling grasshoppers (Orthoptera: Acrididae) on burned and unburned tall grass prairie: night trapping vs. sweeping. Environmental Entomology 12: 1449-1454.

Weather measurements are taken at each watershed before sweeps are completed. These measurements are recorded as CGR021. Time is recorded on a 24-hour scale, along with five wind speeds taken at 30 second intervals 5 feet above the ground.* Cloud coverage that is directly overhead is estimated by eye and recorded. Wind speed and temperature are collected in miles per hour and Fahrenheit using a WindMate 200 (occasionally temperature is taken from truck's thermometer). These numbers are then converted to metric units in excel when the data is being entered. For wind speed all five measurements are entered, then averaged, and finally converted to kilometers per hour. Temperatures is entered as Fahrenheit and converted to Celsius. All conversions are computed in excel using the existing formulas. The previous machine used to measure wind speed had a limit of detection of 5 mph. If the wind was blowing but could not register on the machine, then it was recorded as <5. However, in order to compute an average these measurements were entered as 2.5 mph. Also cloud coverage is sometimes recorded as <5% or as a range of percentages but when the data is entered the largest recorded number is used. (Ex. Recorded as <5%, Entered as 5; Recorded as 10-15%, Entered as 15)

*For the years 1983 – 2011 wind speeds were not always collected in this manner, instead measurements were taken at 5 second intervals or only one speed was recorded. However, the purpose of the weather information is to determine whether or not samples could be collected within the weather parameters as described above. Once collection has begun, and due to variable conditions on the prairie, the judgment of the research tech is employed to determine adequate collection conditions.

Summary of All Changes:

1982-1987: Sites were sampled at various earlier dates in addition to the late July-early August.

1985: Sweeping was restricted to all sites being sampled (twice, on different dates) in late July and early August. Additional watersheds (002D, 004D (now 0SpB), 004F AND 010D (now 0SuB) were added to the sampling regime for early August to provide more long-term data on the influence of fire frequency on grasshoppers. Sampling on watersheds to be grazed (N01B, N04D, and N20B) was discontinued.

1986: Watershed 004G (now 00WB) was temporarily added. Sampling in June and early July was reduced to watersheds 001D, 004D, 010D and 020B only; too few grasshoppers are collected by sweeping in the first half of the summer for all watersheds to merit sampling.

1987: Sampling in June and early July was restricted to sites 001D, 002C, 004B and 004F.

1994: Fire regime changed for 004D (became 0SpB) and 010D (became 0SuB). In the years when 0SuB is burned the sweeps are done 2 weeks earlier than normal. The summer burn is conducted on the first water appropriate day in late July to early August.

1996: Wildfire in February – burned 004F, 0SuB, 001D and 002D.

1998: 0SuB done earlier than other sites (mid-July) under the mistaken idea that the summer burns were to occur this year.

2002: Grazed (bison) transects were added in N01A, N01B, N04A, N04D, N20A and N02B.

An older version of the methods manual indicates that 3 lowland (Tully) sites were once done. Locations were:

001D	A: T-28	004B	A: G-28
	B: S-28		B: F-28
020B	A: N-29		
	B: N-29		

2011: WindMate 200 replaced previous machine used for checking wind speeds. The previous machine had limit of detection of 5mph. WindMate 200 specifications: Temperature -20° to 158°F accuracy $\pm 1.8^\circ$ to 89mph accuracy $\pm 3\%$

C-V2001.3, V2011.4

2013: Beginning with this year, Oecanthinae spp., Gryllidae spp., Tettigoniidae spp., are being added to our list. These are not new species at Konza. We are adding them to the official listing because they are related and ecologically similar.

2016: In years when SuB is burned, pre-burn and post-burn sweeps will be done. Timing for pre-burn will be mid-July and timing for post-burn will be mid-September.

2018: March 14. 004B – A was burned in a wildfire. A third sweep, “C”, will be done in the vicinity of pab011 FC until 2021 when 004b is scheduled to burn per “normal” schedule.

CGR03

Title: Effects of Spring Burning on Grasshopper Nymphs (1982)

Purpose: Monitor changes in species composition of grasshopper assemblages over the course of the summer on unburned areas and areas burned for the first time in 1, 2, or 4 years.

Date data commenced: 06/01/1982

Date data terminated: 09/02/1982

Location of Sampling Stations: All sites on upland (Florence & Dwight-Irwin) soils (1982)

Frequency of Sampling:

20 samples of 20 sweeps each (400 sweeps total) were taken at each of the 10 sites at approximately two week intervals from June 1- September 2, 1982.

Variable Measured: Date, location, time, wind, temperature, and species

Methods:

Sweeps were taken with standard canvas nets 38 cm in diameter by the same two individuals throughout the summer, each of whom took ten sets of 20 sweeps along parallel transects (5-10 m apart) 200 m long. Transects were flagged, enabling sweeps to be taken in the same local areas on each occasion. A sweep was taken at each step by traversing an arc of 180° with the net through the top layer of vegetation. After 20 such sweeps, the contents of the net were emptied into plastic bags. These samples were frozen until grasshoppers were removed and identified.

CGR05

Title: Effects of fire frequency on composition of grasshopper assemblages (1983)

Purpose: Compare species compositions of grasshopper assemblages in August on areas burned at different frequencies.

Date data commenced: 08/05/1983

Date data terminated: 08/10/1983

Location of Sampling Stations: All sites on upland (Florence and Dwight-Irwin) soils (1983).

Frequency of Sampling:

20 samples of 20 sweeps each (400 sweeps total) were taken at each of the 20 sites.

Variable Measured: Date, location, species

Methods:

Sweeps were taken with canvas beating nets 38 cm in diameter. Four individuals took 100 sweeps each at each site. A sweep was taken at each step by traversing an arc of 180° with the net through the top layer of vegetation. After 20 such sweeps, the contents of the net were emptied into plastic bags. These samples were frozen until grasshoppers were removed and identified.

CMY01

Title: Mycorrhizal colonization and plant community responses to long-term suppression of mycorrhizal fungi

Purpose: Study plant community and mycorrhizal colonization response to long-term suppression of mycorrhizal fungi.

Date data commenced: 03/01/1991

Date data terminated: 10/30/1999

Location of Sampling Stations:

Watersheds 1B, 1D, annual burned HQB, 10B, 20D and infrequently burned HQB.

Frequency of Sampling:

To evaluate the effectiveness of the fungicide, three soil cores were removed from both fungicide-treated and control plots each October.

Methods:

Twenty replicate permanent 2x2 m plots were established in early 1991 along a randomly located transect, with a 2m space between each plot, on the following watersheds: 1B, 1D, annually burned HQB, 10B, 20D and infrequently burned HQB. Ten of the plots were randomly assigned as long-term mycorrhizal suppression plots. In each of these plots, AM fungi were suppressed by the application of the fungicide benomyl as a soil drench (7.5 liters per plot) at the rate of 1.25 g/m² (active ingredient). The mycorrhizal suppression plots were treated biweekly throughout each growing season (April through October) beginning in 1991. The control plots each received no fungicide, but an equivalent volume of water (7.5 liters) was applied biweekly. To evaluate the effectiveness of the fungicide, three soil cores (2.5 cm diameter x 14 cm deep) were removed from both fungicide-treated and control plots each October throughout the study. Roots were extracted from the soil, washed free of soil, stained in trypan blue (Phillips and Hayman, 1970), and examined microscopically to assess percentage root colonization by mycorrhizal fungi using a Petri dish scored in 1-cm squares (Daniels et al. 1981).

CPC01

Title: Annual census of greater prairie chickens on leks at Konza Prairie

Purpose: Locate and enumerate the number of lekking males.

Date data commenced: 03/01/1981

Date data terminated: 05/02/2008

Location of Sampling Stations:

Transect 1: Northward along trail from the fireguard on the east side of 020D (grid X-28), then westward on the main ridge trail (U-23 to G-26), then northward to the site manager's house (D-16).

Transect 2: Northward, then eastward on the trail starting just north of the Hokanson house (H-15), eventually moving southward on the margin of Campbell pasture to junction with main ridge trail (U-23).

Frequency of Sampling:

Each transect is run twice in the period from mid-April to early May, the first time in one direction and the second time in the opposite direction.

Variable Measured:

Location of leks and the number of birds flushed from the lek when it is approached by the observer.

Methods:

At the beginning and end of transect, environmental conditions are recorded: temperature, wind speed, sky cover, and hours since the last rainfall if less than 12 hours. The investigator then drives the transect in the proper direction, stopping and listening for sounds of lekking prairie chickens. The grid square (estimated to tenths) of the lek is recorded and the investigator then walks toward the lek, records its exact location on a map if the lek has not been recorded previously, and counts the number of birds flushed. When the location of the lek has been recorded previously, the investigator walks to that site and counts flushed birds even if no lekking sounds are heard.

Survey Conditions and Equipment:

Temperature - no restrictions Phase of moon - no restrictions

Precipitation - should not be conducted during rain

Wind - should not be conducted in winds exceeding 10 mph

Time of day - should be started between sunrise and 1 hr after sunrise

Equipment: 7 x 50 mm binoculars hand anemometer

Suunto azimuth liquid-filled compass (Model KB-14)

Pocket thermometer

Aluminum tally board (E-14 for 8½ x 11 sheets of paper)

CAUTION: Field observer must have good hearing and be alert during early morning period.

Summary of All Changes:

1981-1982: Sampling was done twice: once in mid-March and once in late April, along our transects that were covered by walking.

1983: Transects were reduced to two (present) covered by jeep and data collected only during the present single period in late April or early May.

2009-2010: No data was collected.

CPC02

Title: Census of greater prairie chicken on leks at Konza Prairie

Purpose: Locate and enumerate the number of lekking males.

Date data commenced: 03/25/2000

Date data terminated: 04/26/2004

Location of Sampling Stations:

Transect 1: Northward along trail from the fireguard on the east side of 020D (grid X-28), then westward on the main ridge trail (U-23 to G-26), then northward to the site manager's house (D-16).

Transect 2: Northward, then eastward on the trail starting just north of the Hokanson house (H-15), eventually moving southward on the margin of Campbell pasture to junction with main ridge trail (U-23).

Frequency of Sampling:

Each transect is run twice in the period from mid-April to early May, the first time in one direction and the second time in the opposite direction.

Variable Measured:

Location of leks and the number of birds flushed from the lek when it is approached by the observer.

Methods:

At the beginning and end of transect, environmental conditions are recorded: temperature, wind speed, sky cover, and hours since the last rainfall if less than 12 hours. The investigator then drives the transect in the proper direction, stopping and listening for sounds of lekking prairie chickens. The grid square (estimated to tenths) of the lek is recorded and the investigator then walks toward the lek, records its exact location on a map if the lek has not been recorded previously, and counts the number of birds flushed. When the location of the lek has been recorded previously, the investigator walks to that site and counts flushed birds even if no lekking sounds are heard.

Survey Conditions and Equipment:

Temperature - no restrictions Phase of moon - no restrictions

Precipitation - should not be conducted during rain

Wind - should not be conducted in winds exceeding 10 mph

Time of day - should be started between sunrise and 1 hr after sunrise

Equipment: 7 x 50 mm binoculars hand anemometer

Suunto azimuth liquid-filled compass (Model KB-14) Pocket thermometer

Aluminum tally board (E-14 for 8½ x 11 sheets of paper)

CAUTION: Field observer must have good hearing and be alert during early morning period.

Summary of All Changes:

1981-1982: Sampling was done twice: once in mid-March and once in late April, along four transects that were covered by walking.

1983: Transects were reduced to two (present) covered by jeep and data collected only during the present single period in late April or early May.

2009-2010: No data was collected.

CSA02

Title: Soil Macroarthropod Densities and Biomass on annually burned and unburned watersheds

Purpose: Belowground densities and biomass of macroarthropods were annually measured by hand-sorting techniques. Total herbivore biomass was greater in soils of annually burned sites, and was composed largely of white grubs (Scarabaeidae).

Date data commenced: 11/22/1981

Date data terminated: 04/01/1983

Methods:

The study was conducted on the Konza Prairie Research Natural Area located about 15 km south of Manhattan, Kansas. Vegetation of this area is typical for tallgrass prairie and was dominated by big bluestem (*Andropogon gerardii* Vitman), Indiangrass (*Sorghastrum nutans* (L) Nash) and switchgrass (*Panicum virgatum* L). Further details of vegetation composition are reported in Bragg and Hulbert (1976) and Hulbert (1969). The site used in this study was a bottomland area on a watershed that had not been burned for three years. No grazing by cattle had occurred on this site for 10 years. Soils were fine mixed mesic pachic argiustolls formed in colluvial and alluvial sediments and have been described in Jantz et al. (1975).

A series of 18, 10 m X 10 m plots was established parallel to stream-bank. Treatments (unburned, burned, mowed, and raked three times during growing season) were blocked to remove the variants that might be due to slope effects. The study was initiated in the Spring of 1981, and treatments were continued for two years. Soil arthropods were censused by excavating and hand-sorting two or three 0.1 m² by 20 cm deep soil monoliths per plot (Seastedt 1984a). Rhizomes of grasses were concurrently harvested from these samples and sorted into living and dead components. Arthropods were returned to the laboratory, identified, dried at 70°C and weighed. Samples were obtained when the arthropods were inactive during November 1981 and again in late March and early April of 1983.

Arthropods were identified to family and grouped according to trophic status. Only larger arthropods (macroarthropods) are reported here. Ants and termites were not included in the counts, nor were densities of the very small arthropods (microarthropods). All white grubs (Scarabaeidae) were classified as herbivores; few adult detritivores of this family have been found of ungrazed prairie (Seastedt 1984a).

Most arthropod groups censused in this study exhibited clumped distributions. Therefore, a logarithmic transformation ($y = \log(x + 1)$) was performed prior to statistical analysis to normalize distributions and homogenize variances. Differences in densities and biomass of arthropods attributed to sampling date were assessed by using a two-way ANOVA (date, treatment and interaction) using type-IV sums of squares to establish the potential significance of sampling date. Treatment effects on arthropod densities and biomass were evaluated for each collection date using one-way ANOVA.

Kucera and Dahlman (1968) established a positive correlation between rhizome and root mass and productivity. Living and dead rhizome mass were therefore used as indices of

belowground plant biomass and plant productivity on the treatments. Big bluestem and Indiangrass dominated total rhizome biomass, and only these two species were used in our index of belowground plant productivity. Other indices of plant productivity and nitrogen content of belowground plant materials were obtained from other studies being conducted on Konza Prairie or nearby areas by other investigators.

CSM01

Title: Seasonal summary of numbers of small mammals on 14 LTER traplines in prairie habitats

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in tallgrass prairie as well as to determine the effects of weather patterns, occurrence of fire, frequency of fire, topographic features and bison grazing on populations and communities of small mammals.

Date data commenced: 10/20/1981

Date data terminated: 03/20/2013

Location of Sampling Stations:

Ungrazed, unburned - 020B

Grazed, unburned - N20B

Ungrazed, annual burn - 001D

Grazed, annual burn - N01B

Ungrazed, 4 yr. burn - 004B, 004F

Grazed, 4 yr. burn - N04D

Frequency of Sampling:

All sites are sampled in autumn (early October to mid-November) after most reproduction by small mammals has occurred and before winter stress is significant and in spring (late February to early April) before fire has occurred on those sites to be burned that year to estimate both early spring abundance and winter survival (difference in relative abundance between autumn and spring).

Variable Measured:

Numbers of individuals for each species of small mammal captured are recorded on each trapline. Sex, reproductive condition and capture location of each individual are recorded at each capture. Age, based on pelage characteristics, is recorded for the two species of *Peromyscus* at each capture. Body mass of an individual is recorded only at the first capture in each trapping period.

Methods:

Traplines:

Small mammals are trapped on two permanent traplines in each of seven treatment units. Each trapline consists of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit. When possible, each trapline was placed so that station 1 was in upland (shallow soil) and station 20 in lowland prairie (deeper soil), and so the two traplines within a treatment unit would include about 16 stations in upland, 8 stations across limestone outcrops and 16 stations in lowland. Because of the topographic goals, the two traplines within a treatment unit are not replicates of each other and the topographic goals were not always achieved. Stations 1, 5, 10, 15 and 20 on each trapline are marked with stakes of galvanized conduit. All stations are marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals are trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) are placed within 1 m of the surveyor flag or conduit at each station. Traps are baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal). The mixture is rolled into a small ball (1.5-2.0 cm in diameter) and wrapped in a 10-cm square of weighing paper. The bait is suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. Polyester fiberfill (≈ 5 g) is compressed by a #8 rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduces trap mortality in inclement weather. With the nest material and a large amount of bait in each trap, mammals typically are in good condition at the time that trap are checked in all types of weather. In the event that more than 50% of the traps are closed overnight without an individual captured (e.g., due to strong winds or other weather events such as heavy rain, deer licking traps or raccoons or crows setting off traps), traps are set for additional nights until $< 50\%$ of traps per night are closed without captures on that trapline. Small rocks are placed on traps in habitats that have little cover (e.g., on grazing lawns created by bison) to reduce problems due to wind. During the two trapping sessions each season, bison are removed from the phase II area of the bison enclosures to avoid damage to traps (e.g., stepping or rolling on them) and impacts on trap effectiveness (bison nuzzling or licking traps) and to ensure safety of field personnel.

All traps are checked early each morning, but after the end of the nocturnal activity period. Seven traplines are run simultaneously, one in each treatment, followed by the setting of the next series of traplines in the next week. The first trapline to be trapped in each treatment unit is selected at random by using a random number generator. The time of trapping in each season is selected by attempting to place the dark phase of the moon (no moon) in the middle of the two sampling periods.

A battery-powered mustache clipper is used to clip a line of fur on each captured animal to indicate that that individual has been captured in the current trapping period. The position clipped is as follows: on the right shoulder (first set of traplines in a spring sampling period), left shoulder (second set of traplines in a spring sampling period), right rump (first set of traplines in an autumn sampling period) and left rump (second set of traplines in an autumn sampling period). This method of marking allows an investigator to count an individual only once within a trapline during a trapping period. Further, three species of rodents (*Peromyscus maniculatus*, *P. leucopus* and *Neotoma floridana*) are marked with an ear tag (#1 monel fingerling tags) in each ear in addition to fur clipping to track movements of individuals among treatment units that are related to fire or to invasion of woody vegetation. Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) are recorded at each capture of an individual in each trapping period. Body mass is recorded during the first capture of an individual on a trapline. Reproductive information recorded for males is the presence or absence of scrotal testes. Pregnancy is determined by palpation of the abdomen of females; no effort is made to assess the number of embryos. Presence or absence of conspicuous mammae also is recorded. Conspicuous mammae indicate that the female has been reproductively active and is nursing or has nursed offspring. Individuals are weighed to nearest 0.5 g for those

weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size.

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM01.

Summary of All Changes:

In autumn 1981, two traplines were established in each of ten experimental fire treatments (001D, 004B, 004D, 004F, 004G, 010A, 000B, N01D, N04D and N00D). Live-trap surveys were conducted in spring, summer and autumn; small mammals were marked by toe-clipping procedures. During winter 1981-1982, the Konza Prairie management committee shifted treatment boundaries to create watershed units for those treatment areas that drained into Kings Creek. Because of that decision, our traplines in N00D were encompassed in the new boundaries of N01D. Therefore, we established two new traplines in another treatment unit (N00B) in spring 1982. Also, the experimental designation for N01D was changed to N01B. During spring, summer and autumn 1982, surveys were conducted using 22 traplines; use of the two traplines in N00D was discontinued before the spring 1983 survey. Data for small mammals captured in N00D for spring, summer and autumn sampling periods in 1982 are found in CSM06.

From spring 1983 through summer 1984, censuses were conducted using two traplines in each of ten treatments (001D, 004B, 004D, 004F, 004G, 010A, 000B, N01B, N04D and N00B). In autumn 1984, four new traplines were established with two traplines in 002C and two in 002D (24 total sampling lines). Four more traplines were added in autumn 1985 with two in 010D and two in 001A (28 total sampling lines). After 1987, summer sampling was discontinued because of the intensive labor required to close traps in the morning and open traps in late afternoon each day on each trapline in each trapping period. All data for small mammals captured in summer trapping periods are found in CSM06. In 1988, Konza Prairie management committee changed unburned research treatments to treatments with a 20-year frequency of occurrence of fire and, therefore, 000B and N00B became 020B and N20B, respectively.

The treatment units (N01B and N04D) remained unburned from 1968 until spring 1988 when annual burning was initiated on N01B and the 4-year cycle was initiated on N04D. Spring fires occurred after our trapping session in these and other treatment units. N20B was not burned in 1988, but it had been burned in 1980.

Before the spring sampling period in 1989, the number of traplines sampled was reduced from 28 traplines to 14; the 14 traplines remaining included two traplines in each of seven experimental treatments (001D, 004B, 004F, 020B, N01B, N04D and N20B). Selection of these 14 traplines was based on the goal of maintaining the sampling of small mammals in annual, 4-year and 20-year burn treatments in both ungrazed prairie (001D, 004B and 020B, respectively) and in the same fire treatments in prairie grazed by bison (N01B, N04D and N20B). In addition, a second ungrazed 4-year fire treatment (004F) was continued to help monitor climatic effects on small mammals in prairie experiencing periodic fires. Data for small mammals captured on traplines that were discontinued (001A, 002C, 002D, 004D, 004G, 010A and 010D) can be found in CSM06.

In autumn 1990, we started clipping hair at the first capture of a small mammal in each season in exchange for the more invasive clipping of ≤ 1 digit per foot, which had been used since 1981 to identify individuals. Hair clipping allowed enumeration of the number of different individuals per species captured along each trapline, which was all that was required for maintenance of the CSM01 data set. In autumn 2008, we started ear-tagging deer mice, white-footed mice and eastern woodrats to gain more information about how new fire treatments near the 14 core traplines and how the invasion of woody vegetation was affecting movements of these three species.

In May 1992, gates were opened between phase I and phase II of the bison area. N01B, N04D and N20B lie within the phase II area. All sampling periods from autumn 1981 through spring 1992 on these three treatment units occurred on traplines that had not been grazed by bison.

CSM02

Title: Seasonal summary of numbers of small mammals on the four LTER gallery forest and limestone ledges traplines in wooded habitats at Konza Prairie

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in gallery forest and wooded limestone ledges and to compare these values to the fourteen prairie core traplines (CSM01).

Date data commenced: 12/01/1981

Date data terminated: 03/28/1988

Location of Sampling Stations:

Ungrazed, gallery forest – N01A (G), N04B (XP)

Ungraded, wooded limestone ledges – N02B (L1), N01A (L2)

Frequency of Sampling:

All sites were sampled in autumn (mid-October to early December), spring (early March to early April) and summer (early July to late July).

Variable Measured:

Numbers of individuals for each species of small mammal captured were recorded on each trapline. Sex, reproductive condition and capture location of each individual were recorded at each capture. Age, based on pelage characteristics, was recorded for the two species of *Peromyscus* at each capture. Body mass of an individual was recorded only at the first capture in each trapping period.

Methods:

Traplines:

Small mammals were trapped on two permanent traplines in each habitat type (gallery forest and associated limestone ledges). Each trapline consisted of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit and ≥ 150 m between traplines. Traplines G and XP were part of a large irregular grid (843 trap stations; see Kaufman et al 1983) established in summer 1981. These traplines were straight linear traplines through the gallery forest habitat, whereas traplines L1 and L2 followed the contours of the exposed limestone ledges. A more complete description of these four traplines relative to each other can be found in Kaufman et al. (1993). Stations 1, 5, 10, 15 and 20 on each trapline were marked with stakes of galvanized conduit. All stations were marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals were trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) were placed within 1 m of the surveyor flag or conduit at each station. Traps were baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal) in spring and autumn. The mixture was rolled into a small ball (1.5-2.0 cm in diameter) and

wrapped in a 10-cm square of weighing paper. The bait was suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. In the summer trapping period, peanut butter was placed on the inside of the back door of the trap. Polyester fiberfill (≈ 5 g) was compressed by a #8 rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduced trap mortality in inclement weather. With the nest material and a large amount of bait in each trap, mammals typically were in good condition at the time that trap were checked in all types of weather. In the event that $\geq 50\%$ of the traps were closed overnight without an individual captured (e.g., due to raccoons running the traplines and setting off traps), traps were set for additional nights until $< 50\%$ of traps per night were closed without captures on that trapline. In the event that raccoon disturbances occurred multiple nights within a trapping period, large animal wire-cage traps were set for the raccoons, and when captured, the raccoons were moved out of the area to other wooded habitats on Konza Prairie, so that the trapping period could be completed.

All traps were checked early each morning, but after the end of the nocturnal activity period. All four traplines were run simultaneously. Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) were recorded at first and subsequent captures of an individual in each trapping period. Body mass was recorded during the first capture of an individual on a trapline. Individuals were toe-clipped (≤ 1 digit removed per foot) at their first capture so that individuals could be uniquely identified within and across trapping periods and traplines. Reproductive information recorded for males was the presence or absence of scrotal testes. Pregnancy was determined by palpation of the abdomen of females; no effort was made to assess the number of embryos. Presence or absence of conspicuous mammae also was recorded. Conspicuous mammae indicated that the female had been reproductively active and had nursed offspring. Individuals were weighed to nearest 0.5 g for those weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size.

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM02.

Summary of All Changes up to 1988:

Bison did not graze any of the treatment units during the duration of the study. Traplines G and L2 were burned in spring 1980, 1984, 1986 and 1986, whereas XP was burned in spring 1980 and 1985. Trapline L1 was not burned during the duration of the study. No changes were made to the methods during the study period.

References:

- Kaufman, D. W., G. A. Kaufman and E. J. Finck. 1993. Small mammals of wooded habitats of the Konza Prairie Research Natural Area, Kansas. *Prairie Naturalist* 25:27-32.
- Kaufman, D. W., S. K. Peterson, R. Fristik and G. A. Kaufman. 1983. Effect of microhabitat features on habitat use by *Peromyscus leucopus*. *American Midland Naturalist* 110:177-185.

CSM03

Title: Seasonal summary of numbers of small mammals on the two LTER traplines in planted grassland (Brome fields) habitats

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in planted grassland (brome field) and to compare these values to the fourteen prairie core traplines (CSM01).

Date data commenced: 11/06/1981

Date data terminated: 10/16/1987

Location of Sampling Stations:

Ungrazed brome fields – N01A (BrS), K04A (BrN)

Frequency of Sampling:

Both sites were sampled in autumn (mid-October to mid-November), spring (early March to mid-April) and summer (early July to early August).

Variable Measured:

Numbers of individuals for each species of small mammal captured were recorded on each trapline. Sex, reproductive condition and capture location of each individual were recorded at each capture. Age, based on pelage characteristics, was recorded for the two species of *Peromyscus* at each capture. Body mass of an individual was recorded only at the first capture in each trapping period.

Methods:

Traplines:

Small mammals were trapped on two permanent traplines in planted brome fields near Kings Creek. Each trapline consisted of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit. Stations 1, 5, 10, 15 and 20 on each trapline were marked with stakes of galvanized conduit. All stations were marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals were trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) were placed within 1 m of the surveyor flag or conduit at each station. Traps were baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal) in spring and autumn. The mixture was rolled into a small ball (1.5-2.0 cm in diameter) and wrapped in a 10-cm square of weighing paper. The bait was suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. In the summer trapping period, peanut butter was placed on the inside of the back door of the trap.

Polyester fiberfill (≈ 5 g) was compressed by a #8 rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduced trap mortality in inclement weather. With the nest material and a large amount of bait in each

trap, mammals typically were in good condition at the time that trap were checked in all types of weather. In the event that $\geq 50\%$ of the traps were closed overnight without an individual captured (e.g., due to raccoons running the traplines and setting off traps), traps were set for additional nights until $< 50\%$ of traps per night were closed without captures on that trapline. In the event that raccoon disturbances occurred multiple nights within a trapping period, large animal wire-cage traps were set for the raccoons, and when captured, the raccoons were moved out of the area to other wooded habitats on Konza Prairie, so that the trapping period could be completed.

All traps were checked early each morning, but after the end of the nocturnal activity period. Both traplines were run simultaneously. Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) were recorded at first and subsequent captures of an individual in each trapping period. Body mass was recorded during the first capture of an individual on a trapline. Individuals were toe-clipped (≤ 1 digit removed per foot) at their first capture so that individuals could be uniquely identified within and across trapping periods. Reproductive information recorded for males was the presence or absence of scrotal testes. Pregnancy was determined by palpation of the abdomen of females; no effort was made to assess the number of embryos. Presence or absence of conspicuous mammae also was recorded. Conspicuous mammae indicated that the female had been reproductively active and had nursed offspring. Individuals were weighed to nearest 0.5 g for those weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size.

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM03.

Summary of All Changes up to 1988:

Bison did not graze any of the treatment units during the duration of the study. The south brome trapline was burned in spring 1980, 1984, 1985, 1986 and 1987, whereas the north brome trapline was burned in spring 1980 and 1985. No changes were made to the methods during the study period.

CSM04

Title: Seasonal summary of numbers of small mammals on the eight LTER seasonal burn traplines in prairie habitats

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in tallgrass prairie as well as assess the effects of burning the prairie in different seasons (autumn, winter, spring and summer) on populations and communities of small mammals.

Date data commenced: 10/17/1994

Date data terminated: ongoing

Location of Sampling Stations:

Ungrazed, annual burn in autumn - FA, FB

Ungrazed, annual burn in winter - WA, WB

Ungrazed, annual burn in spring - SpB

Ungrazed, annual burn in summer - SuB

Frequency of Sampling:

All sites are sampled in autumn (early October to early November) and in spring (early March to early April).

Variable Measured:

Numbers of individuals for each species of small mammal captured are recorded on each trapline. Sex, reproductive condition and capture location of each individual are recorded at each capture. Age, based on pelage characteristics, is recorded for the two species of *Peromyscus* at each capture. Body mass of an individual is recorded only at the first capture in each trapping period. See sample data sheet (Fig. 12).

Methods:

Traplines:

Small mammals are trapped on two permanent traplines in each habitat type. The two traplines in fall and winter burns are in different treatment units (FA and FB for fall burns and WA and WB for winter burns), whereas the two traplines in spring and summer burns are in the same treatment unit (SpB for spring and SuB for summer). Each trapline consists of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit. When possible, each trapline was placed so that station 1 was in upland (shallow soil) and station 20 in lowland prairie (deeper soil). Relative to burn type, the two traplines within a treatment unit or in different treatment units include a mix of stations in upland, slope (limestone outcrops or breaks) and lowland prairie. Because of topographic limitations, the two traplines within a treatment unit or in different treatment units are not replicates of each other. Stations 1, 5, 10, 15 and 20 on each trapline are marked with stakes of galvanized conduit. All stations are marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals are trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) are placed within 1 m of the surveyor flag or conduit at each station. Traps are baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal). The mixture is rolled into a small ball (1.5-2.0 cm in diameter) and wrapped in a 10-cm square of weighing paper. The bait is suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. Polyester fiberfill (≈ 5 g) is compressed by a #8 rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduces trap mortality in inclement weather. With the nest material and a large amount of bait in each trap, mammals typically are in good condition at the time that traps are checked in all types of weather. In the event that more than 50% of the traps are closed overnight without an individual captured (e.g., due to strong winds or other weather events such as heavy rain, deer licking traps or raccoons or crows setting off traps), traps are set for additional nights until $< 50\%$ of traps per night are closed without captures on that trapline. Small rocks are placed on traps in autumn and winter burns during the spring trapping session because no vegetative cover exists on these four traplines due to the timing of these burns.

All traps are checked early each morning, but after the end of the nocturnal activity period. All eight traplines are run during the same 4-day trapping period. The time of trapping in each season is set by the 14 core LTER traplines in that the seasonal burns are trapped directly before or after these traplines. The 14 core LTER traplines are trapped in the dark phase of the moon (no moon), so the amount of moonlight is variable due to cloud cover and moon phase on the seasonal fire traplines.

A battery-powered mustache clipper is used to clip a line of fur on each captured animal to indicate that that individual has been captured in the current trapping period. The position clipped is as follows: on the lower back in a spring sampling period and upper back in an autumn sampling period. This method of marking allows an investigator to count an individual only once within a trapline during a trapping period. Further, three species of rodents (*Peromyscus maniculatus*, *P. leucopus* and *Neotoma floridana*) are marked with an ear tag (#1 monel fingerling tags) in each ear in addition to fur clipping to track movements of individuals among treatment units that are related to fire. Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) are recorded at each capture of an individual in each trapping period. Body mass is recorded during the first capture of an individual on a trapline. Reproductive information recorded for males is the presence or absence of scrotal testes. Pregnancy is determined by palpation of the abdomen of females; no effort is made to assess the number of embryos. Presence or absence of conspicuous mammae also is recorded. Conspicuous mammae indicate that the female has been reproductively active and is nursing or has nursed offspring. Individuals are weighed to nearest 0.5 g for those weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM04.

Summary of All Changes:

In autumn 1993, one trapline was established in four treatment units (FA, FB, WA and WB). Traplines in SpB and SuB were established earlier because the two traplines in SpB are the same permanent traplines established in autumn 1981 (west trapline is A and east trapline is B) for 004D and traplines in SuB are the same traplines established in autumn 1985 (west trapline is A and east trapline is B) for 010D. Previously, FA was a 4-year burn treatment (004E), FB (also designated initially as 004Ff) was a treatment unit that was unburned except in wet years (WC), WA was a treatment unit that was unburned for 3 consecutive years and then burned for 3 consecutive years (3U3BB) and WB was a 4-year burn treatment (004G, but note that the trapline is not the same as that established in 1981 because the Konza Prairie management removed the flags from these permanently marked stations in the interim).

The treatment unit (SuB) has been burned biennially instead of annually because vegetation recovery after a July burn is not great enough to sustain a burn the following summer.

In autumn 2007, we started ear-tagging deer mice in addition to the clipping of fur on 004F, SuB and WB to gain more information about how the seasonal fire treatments near the 004F (core LTER) traplines were affecting movements of this fire-positive species. Subsequently, we started ear-tagging deer mice on the remainder of the seasonal burns in spring 2008 as well as two other species, white-footed mice and eastern woodrats, to gain information about these two species relative to invasion of woody vegetation.

CSM042: seasonal individual data Changes: Made some watershed name changes based on the information from Dr. Don Kaufman, June 2018: spb - historically known as 4d (on datasheets: spra, spr-a, spr-w = 0spb-a (watershed-line); sprb, spr -, spr-be, spr-b = 0spb-B) 0sub – historically 10d (on datasheets: sum-a, smr-w, smr-a = 0sub-A; sum-b, smr-b, smr-e = 0sub-B) 00fa – historically 4e (datasheets: 000e, 004e, flla, fll-a = 00fa-A) 00fb – historically 4ff (datasheets: 000f, 04Ff, fllb, fll-b = 00fb-B) 00wa – historically 3u3bb (datasheets: wnta, wnt-a = 00wa-A) 00wb – historically 4g (on datasheets: wnb, wntb, wnt-b = 00wb-b).

CSM05

Title: Seasonal summary of numbers of small mammals on the six LTER traplines in prairie habitats on which fire regime has been reversed at Konza Prairie

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in tallgrass prairie as well as assess the effects of reversing fire regimes (from long-term unburned to annually burned and vice versa) on populations and communities of small mammals in contiguous fire treatments.

Date data commenced: 12/07/1999

Date data terminated: ongoing

Location of Sampling Stations:

Ungrazed, unburned – R20A

Ungrazed, annual burn – R01A

Frequency of Sampling:

Both sites are sampled in autumn (late October to early December) and in spring (mid-March to early April).

Variable Measured:

Numbers of individuals for each species of small mammal captured are recorded on each trapline. Sex, reproductive condition and capture location of each individual are recorded at each capture. Age, based on pelage characteristics, is recorded for the two species of *Peromyscus* at each capture. Body mass of an individual is recorded only at the first capture in each trapping period. See sample data sheet (Fig. 12).

Methods

Traplines:

Small mammals are trapped on three permanent traplines in both treatment units. Traplines A and B on each treatment consist of 20 stations with an inter-station distance of 15 m. Trapline C on each treatment has 10 stations with the same inter-station distance as traplines A and B. Because of the limitations of size of treatments and topography, our goal in this study was to have 100 trapnights within a treatment each night that we trapped. Stations 1, 5, 10, 15 and 20 on trapline A and B and stations 1, 5 and 10 on trapline C are marked with stakes of galvanized conduit. All stations are marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals are trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) are placed within 1 m of the surveyor flag or conduit at each station. Traps are baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal). The mixture is rolled into a small ball (1.5-2.0 cm in diameter) and wrapped in a 10-cm square of weighing paper. The bait is suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. Polyester fiberfill (≈ 5 g) is compressed by a #8

rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduces trap mortality in inclement weather. With the nest material and a large amount of bait in each trap, mammals typically are in good condition at the time that trap are checked in all types of weather. In the event that more than 50% of the traps are closed overnight without an individual captured (e.g., due to strong winds or other weather events such as heavy rain or deer licking traps), traps are set for additional nights until < 50% of traps per night are closed without captures on that trapline.

All traps are checked early each morning, but after the end of the nocturnal activity period. All six traplines are run during the same 4-day trapping period. Generally, the reversal traplines are run after LTER core traplines and seasonal fire traplines in both seasons. Thus the amount of moonlight present during the trapping period is variable across seasons and years due to cloud cover and moon phase for the reversal traplines.

A battery-powered mustache clipper is used to clip a line of fur on each captured animal to indicate that that individuals has been captured in the current trapping period. The position clipped is dependent upon the trapline and occurs as follows: on the right shoulder (on R01A-A trapline in a spring sampling period), left shoulder (on R20A-A trapline in a spring sampling period), right rump (on R01A-A trapline in an autumn sampling period) and left rump (on R20A-A trapline in an autumn sampling period). For traplines B and C on each treatment area, the upper back is marked in an autumn sampling period and upper back in a spring sampling period. The reason for this difference in marking position is that the two A traplines are very close to each other and by marking the animals captured differently, we can determine if an individual has crossed the firebreak within a trapping period. Likewise, this method of marking allows an investigator to count an individual only once within a trapline during a trapping period. Further, three species of rodents (*Peromyscus maniculatus*, *P. leucopus* and *Neotoma floridana*) are marked with an ear tag (#1 monel fingerling tags) in each ear in addition to fur clipping to track movements of individuals among treatment units that are related to fire or to invasion of woody vegetation. Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) are recorded at each capture of an individual in each trapping period. Body mass is recorded during the first capture of an individual on a trapline. Reproductive information recorded for males is the presence or absence of scrotal testes. Pregnancy is determined by palpation of the abdomen of females; no effort is made to assess the number of embryos. Presence or absence of conspicuous mammae also is recorded. Conspicuous mammae indicate that the female has been reproductively active and is nursing or has nursed offspring. Individuals are weighed to nearest 0.5 g for those weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size.

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM05.

Summary of All Changes:

We began trapping small mammals along the permanent traplines in December 1999 before the fire treatments were reversed. The treatment unit 001A (which was to become

R20A) was burned annually from 1972 through 2000. In spring 2001, it became a long-term unburned site except for an accidental wildfire that occurred in spring 2008 after we had completed our small mammal surveys. The treatment unit 020A (which was to become R01A) was unburned except by wildfires in 1980 and 1991 before annual spring burning began in spring 2001. Note that the traplines on R20A are not the same as those used previously in 001A (CSM06).

At the beginning of the reversal of the fire regimes on these two treatment units, we intensively trapped small mammals. From December 1999 through December 2001, we used two methods of individually marking small mammals. On each small mammal, we both toe-clipped and applied an ear tag to the right ear of an individual (except for shrews). To uniquely identify an individual by toe clipping, we removed at most 1 digit per foot. Ear tags (each with a unique number) also were used, but ear tags are often lost, especially if only one ear is tagged and, subsequently, the history of that individual also is lost. These methods of marking allowed us to both identify individuals across traplines on the two treatment units and among trapping periods. Generally, both treatment units were trapped before the spring fire in March or April and then after the spring fire in May, June and then November-December from 2000 to 2002. We continued the general trapping plan in 2003, but used hair-clipping on different positions of the body to track small mammals among different trapping periods. After 2003, hair clipping was solely used as described above in the Methods and sampling occurred only in the spring and autumn of each year. Hair clipping allowed enumeration of the number of different individuals per species captured along each trapline, but not individual recognition. In spring 2008, we started ear-tagging deer mice, white-footed mice and eastern woodrats in addition to hair clipping to gain more information about how these different fire regimes are affecting movements of these three species given the change in vegetation since the beginning of the study.

Small mammals were not trapped on these traplines in autumn 2003 and spring 2009.

CSM06

Title: Seasonal summary of numbers of small mammals on miscellaneous traplines in prairie habitats that were trapped from 1 to 11 years at Konza Prairie

Purpose: Determine temporal and spatial patterns of relative abundance of rodent and shrew populations and composition of assemblages of small mammals in tallgrass prairie in various burn regimes to compare to the fourteen core traplines (CSM01).

Date data commenced: 1981 Fall

Date data terminated: 1993 Spring

Location of Sampling Stations:

Ungrazed, unburned – 020B (summer only)
Grazed, unburned – N20B (summer only)
Ungrazed, annual burn – 001D (summer only)
Grazed, annual burn – N01B (summer only)
Ungrazed, 4 yr. burn – 004B, 004F (summer only)
Grazed, 4 yr. burn – N04D (summer only)
Ungrazed, annual burn – 001A
Ungrazed, 2 yr. burn – 002C, 002D
Ungrazed, 4 yr. burn – 004D, 004G
Ungrazed, 10 yr. burn – 010A, 010D
Ungrazed, unburned – N00D

Frequency of Sampling:

All sites were sampled in autumn (early October to mid-November), in spring (early March to early April) and summer (late June to late July). Summer samples also include data from 020B, N20B, 001D, N01B, 004B, 004F and N04D (the seven core LTER treatment units for small mammal).

Variable Measured:

Numbers of individuals for each species of small mammal captured were recorded on each trapline. Sex, reproductive condition and capture location of each individual were recorded at each capture. Age, based on pelage characteristics, was recorded for the two species of *Peromyscus* at each capture. Body mass of an individual was recorded only at the first capture in each trapping period. See sample data sheet (Fig. 12).

Methods:

Traplines:

Small mammals were trapped on two permanent traplines in each treatment unit. Each trapline consisted of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit. When possible, each trapline was placed so that station 1 was in upland (shallow soil) and station 20 in lowland prairie (deeper soil). For the non-core LTER traplines, the two traplines within a treatment unit included a mix of stations in upland, slope (limestone outcrops or breaks) and lowland prairie. Because of topographic limitations, the two traplines within a treatment unit were

not replicates of each other. Stations 1, 5, 10, 15 and 20 on each trapline were marked with stakes of galvanized conduit. All stations were marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures:

Small mammals were trapped for 4 consecutive nights per trapline during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) were placed within 1 m of the surveyor flag or conduit at each station. Traps were baited with a mixture of high-quality creamy peanut butter (e.g., Jif) and oatmeal (Quaker old-fashioned oatmeal). The mixture was rolled into a small ball (1.5-2.0 cm in diameter) and wrapped in a 10-cm square of weighing paper. The bait was suspended in the trap by closing the back door of the trap on the twisted end of the weighing paper. In the summer trapping period, peanut butter was placed on the inside of the back door of the trap. Polyester fiberfill (≈ 5 g) was compressed by a #8 rubber band and used as nesting material in each trap in spring and autumn sampling periods. This nesting material reduced trap mortality in inclement weather. With the nest material and a large amount of bait in each trap, mammals typically were in good condition at the time that trap were checked in all types of weather. In the event that $> 50\%$ of the traps were closed overnight without an individual captured (e.g., due to strong winds or other weather events such as heavy rain, deer licking traps or raccoons or crows setting off traps), traps were set for additional nights until $< 50\%$ of traps per night were closed without captures on that trapline.

All traps were checked early each morning, but after the end of the nocturnal activity period. One trapline in each treatment was set, followed by the second in the next week. The first trapline to be trapped in each treatment unit was selected at random by using a random number generator.

Species, sex and reproductive condition of individual small mammals, trap station and any unusual features (e.g., the presence of ticks, fleas or bot fly larvae, variation in color pattern such as stars or blazes) were recorded at each capture of an individual in each trapping period. Body mass was recorded during the first capture of an individual on a trapline. Reproductive information recorded for males was the presence or absence of scrotal testes. Pregnancy was determined by palpation of the abdomen of females; no effort was made to assess the number of embryos. Presence or absence of conspicuous mammae also was recorded. Conspicuous mammae indicated that the female had been reproductively active and had nursed offspring. Individuals were weighed to nearest 0.5 g for those weighing ≤ 50 g and nearest 1 g for those weighing > 50 g by using Pesola balances of an appropriate size.

Form of Data Output:

The total number of mammals captured by species by trapline forms the database CSM06.

Summary of All Changes up to 2010:

Because these miscellaneous traplines were part of CSM01 in early years of LTER, see CSM01 "Summary of Changes" for changes made from autumn 1981 through autumn 1988.

CSM08

Title: Small mammal host-parasite sampling data for 16 linear trapping transects located in 8 LTER burn treatment watersheds.

Purpose: Determine temporal and spatial variability in occurrence of rodent and shrew taxa and general assemblages of small mammals through tallgrass prairie and shrubland habitats on the Konza LTER as well as to determine the effects of long-term climate fluctuations, occurrence of fire, and frequency of fire, on distribution, abundance, richness, and diversity of communities of small mammals. Additionally, determine changes in genetic diversity of both small mammal populations and their associated ecto- and endo-parasites (including macro- and micro-parasites/pathogens) that will expand knowledge of community assembly, turnover, and interdependency of associated species in response to major environmental drivers.

Date data commenced: 07/01/2016

Date data terminated: ongoing

Location of Sampling Stations:

Ungrazed, annual burn – 001D

Ungrazed, 4 yr. burn – 004B, 004F

Ungrazed, unburned – 020B

Ungrazed, annual “seasonal” burn – SpB, SuB

Ungrazed, reversal burn – R1A, R20A

Frequency of Sampling:

All sites are sampled in summer (June through August) at least two months following spring burning. Two linear transects occur within each of eight treatment watersheds, one for catch-and-release sampling, and one for specimen removal and archive. Transects for catch-and-release or removal were initially chosen randomly, but kept constant across years. Sampling consists of one period of four concurrent nights of trapping per linear transect per year. Four transects are sampled at once (40 traps per transect, totaling 160 total traps) for four consecutive sampling periods (total 16 transects sampled per year). Sampling periods alternate between four catch-and-release transects and four removal transects. Groups of four transects were chosen randomly, but thereafter groups are sampled consistently across years, and in the same order each year.

Variable Measured:

Numbers of individuals for each species of small mammal captured are recorded on each trapline. Sex, reproductive condition and capture location of each individual are recorded at each capture. Age, based on pelage characteristics, is recorded at each capture. Body mass and measurements of individuals are recorded at first capture in each trapping period. Each capture on catch-and-release transects is provided a unique ear tag number. Each capture on removal transects is euthanized according to accepted and permitted protocols (IACUC permit #3579; Sikes et al., 2016: Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education). Resulting specimens are processed through standardized procedures (Hope et al. In Prep) to retrieve all ecto-parasites, endo-parasites, tissues preserved for genetic analyses, study skins, skeletal

material, internal reproductive condition, and tissues preserved for isotopic analyses. All specimens are preserved in perpetuity, with all associated parts, in the Museum of Southwestern Biology, or the Denver Museum of Nature & Science.

Methods:

Traplines: Small mammals are trapped on two permanent linear transects in each of eight treatment units. Each transect consists of 20 stations with an inter-station distance of 15 m and terminal stations (1 and 20) at least 50 m from the boundary of the treatment unit. When possible, each transect was placed so that station 1 was in upland (shallow soil) and station 20 in lowland prairie (deeper soil), and so the two transects within a treatment unit would include about 16 stations in upland, 8 stations across limestone outcrops and 16 stations in lowland. Because of the topographic goals, the two transects within a treatment unit are not replicates of each other and the topographic goals were not always achieved. Stations 1, 5, 10, 15 and 20 on each transect are marked with tall stakes of galvanized conduit and other stations are marked with short stakes. All stations are marked with fluorescent orange plastic surveyor flags at least once per year.

Trapping Procedures: Small mammals are trapped for 4 consecutive nights per transect during each trapping period. Two large Sherman live traps (7.6 by 8.9 by 22.9 cm) are placed within 1 m of the surveyor flag or conduit at each station. Traps are baited with a small amount (~2tbsp) cracked (non-viable) oats. All traps are set in the evening within two hours of dusk, and checked early each morning, but after the end of the nocturnal activity period. Four traplines are run simultaneously.

CSM09

Title: Small mammal host-parasite sampling data associated with the conSME herbivore exclusion plots across two burned and native-grazed watersheds at Konza Prairie

Purpose: To collect small mammal host-parasite data during one 4-night trapping period during the fall.

Date data commenced: 01/04/2022

Date data terminated: ongoing

Location of Sampling Stations:

Burned annually (N1A)

Burned every 4 years (N4B)

Frequency of Sampling:

These sampling records are based on nightly captures during one 4-night trapping period in fall (October concurrent with annual bison roundup activities) for each of 4 permanent trapping grids established on two fire/grazing treatments (two grids per treatment).

Variable Measured:

Numbers of individuals for each species of small mammal captured are recorded on each trapping grid. Sex, reproductive condition and capture location of each individual are recorded at each capture. Age, based on pelage characteristics, is recorded at each capture. Body mass and measurements of individuals are recorded at first capture in each trapping period. Each capture on catch-and-release grids is provided a unique ear tag number. Each capture on removal transects is euthanized according to accepted and permitted protocols (IACUC permit #4544; Sikes et al., 2016: Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education). Resulting specimens are processed through standardized procedures (Galbreath et al. 2019) to retrieve all ecto-parasites, endo-parasites, tissues preserved for genetic analyses, study skins, skeletal material, internal reproductive condition, and tissues preserved for isotopic analyses. All specimens are preserved in perpetuity, with all associated parts, in the Museum of Southwestern Biology, or the Kansas State Biorepository.

Methods:

Traps: These treatments are both grazed by native grazers (bison) and include one treatment burned annually (N1A) and one treatment burned every 4 years (N4B). In each treatment, sampling grids are arranged as 5 x 10 permanent stakes spaced 10m apart and labeled numerically between 1-50 for grid A and 51-100 for grid B. One grid per treatment (grid A) is sampled using capture-mark-release methods and the other grid in each treatment (grid B) is sampled using specimen removal and subsequent whole body processing and curation.

Trapping Procedures: Small mammals are trapped for 4 consecutive nights during each trapping period. One large Sherman live trap (7.6 by 8.9 by 22.9 cm) is placed next to each stake on each grid totaling 50 traps per grid, across four grids total. Traps are baited with a small amount (~2tbsp) cracked (non-viable) oats. All traps are set in the evening within two hours of dusk, checked early each morning, but after the end of the nocturnal activity period.

GIS Data

GIS00_70

Title: Geographical Information System coverages of Konza Prairie

Purpose: A variety of spatial datasets exist for Konza Prairie Biological Station in zipped (.zip) shapefile (.shp) format. These datasets define locations of boundaries, sampling locations, structures, research treatments, burn histories, and other site characteristics and features.

This dataset is separated into the following sub-sets:

GIS00 GIS Coverages Defining the Site Boundary of Konza Prairie (1977-present)

GIS01 GIS Coverages Defining Internal Boundaries of Konza Prairie (1977-present)

GIS02 GIS Coverages Defining the Konza Prairie Experimental Watershed Treatments

GIS05 GIS Coverages Defining Konza Prairie Burn History (1977-present)

GIS10 GIS Coverage Defining Roads in and around Konza Prairie (1977-present)

GIS11 A GIS Coverage Defining Nature Trails on Konza Prairie (1982-present)

GIS13 GIS Coverages Defining Konza Wildfire and Supplementary Burn History (1977-present)

GIS19 A GIS Coverage Defining Permanent Structures on Konza Prairie (1977-present)

GIS20 GIS Coverages Defining Konza Elevations

GIS21 GIS Coverages Defining Water Bodies on Konza Prairie (1972-present)

GIS22 GIS Coverage Defining Soils (SSURGO) on Konza Prairie (1982-present)

GIS30 GIS Coverages Defining Sample Locations for Abiotic Datasets on Konza Prairie (1972-present)

GIS35 GIS Coverages Defining Sample Locations for Belowground Datasets on Konza Prairie (1982-present)

GIS40 GIS Coverages Defining the Sample Locations of Konza Consumer Data (1982-present)

GIS45 GIS Coverages Defining the Konza Nutrient Data Sample Locations (1982-present)

GIS50 Coverages Defining the Konza Producer Data Sample Locations (1982-present)

GIS55 GIS Coverages Defining the Konza HQ Irrigation System (1982-present)

GIS60 GIS Coverages Defining Other Konza Sample and Research Areas (1982-present)

GIS68 GIS Coverages of Konza Prairie Research Experiments in 2020

GIS70 Konza Prairie Woody Plant Mapping in Core Watersheds (1D, 20B, and 4B) in 2019

Date data commenced:

1972 (GIS21, GIS30); 1977 (GIS00, GIS01, GIS02, GIS05, GIS10, GIS13, GIS19); 1982 (GIS11, GIS22, GIS35, GIS40, GIS45, GIS50, GIS55, GIS60); 2006 (GIS20); 2019 (GIS70); 2020 (GIS68)

Date data terminated: ongoing

Location of Sampling Stations: Konza Prairie Biological Station

Frequency of Sampling: First sample at experiment setup, by request or when update needed

Variable Measured: Please see GIS shapefile attribute table

Methods:General GIS Methods:

The spatial data were mapped in the field using a Trimble Geo7x GPS unit with ArcPad 10.2 software or on a Trimble R1 receiver using Collector for ArcGIS. The maximum PDOP was set at 1.5 meters and number of positions to average were set at 5 points and 5 vertices.

Methods for GIS70:

Woody plants in watersheds 1D, 20B, and 4B were mapped using ArcPad 10.2 software on Trimble Juno 3B GPS units. The maximum PDOP was set at 2.5 meters and number of positions to average were set at 5 points and 5 vertices. Technicians completed mapping systematically using a 25-meter by 25-meter grid displayed on their GPS units and a printed map. This grid subdivided each watershed into manageable plots. To track progress throughout each watershed, the grid on the printed map was shaded once all woody plants in each plot were mapped.

All trees were mapped and identified to species with a point marked at the tree's trunk. Each tree's height was estimated using these categories:

- Less than 1 meter
- 1 to 3 meters
- 3 to 5 meters
- Greater than 5 meters

Eight shrub species were mapped:

- False indigo bush (*Amorpha fruticosa*)
- Rough-leaf dogwood (*Cornus drummondii*)
- Pale dogwood (*Cornus obliqua*)
- American plum (*Prunus americana*)
- Chicksaw plum (*Prunus angustifolia*)

- Aromatic sumac (*Rhus aromatica*)
- Smooth sumac (*Rhus glabra*)
- Pricklyash (*Zanthoxylum americanum*)

Shrubs were mapped as either polygons or points depending on size. If a shrub was less than a meter at its widest point, it was marked as a point at the plant's center and its dimensions were estimated. If greater than a meter wide, the technician walked the plant's perimeter and obtained a polygon for the shrub.

For mapping trees, sometimes the GPS lost its signal under the tree canopy or it was impossible to reach the trunk of the tree (due to low growing branches or dense shrubs). In these situations, a point was taken as close to the tree as the GPS signal allowed or technician could reach. The technician documented about how many feet and which direction the point needed to be moved. Once back in the lab, the point was moved manually in Esri's ArcMap software based on notes taken in the field. Measurements will be repeated every 5 years.

Summary of All Changes:

2019: updated GIS00, GIS01, GIS05, GIS10, GIS11, GIS40, GIS45, GIS50, GIS60

2020: added GIS68, and GIS70; updated GIS19 and GIS30

Nutrient Data

NBC01

Title: Belowground Plot Experiment: Soil Chemistry responses to experimental manipulations of fire, nutrients and mowing

Purpose: To measure the effects of burning, mowing, and N and P fertilization on PH; available P; exchangeable, soluble and total-N; cation exchange capacity; exchangeable Ca, Mg, and K; extractable Fe, Mn, Zn, and Cu; and total-P.

Date data commenced: 06/01/1986

Date data terminated: 08/22/1990

Location of Sampling Stations:

Grid B-16 behind the stone house. The soil on the sites is an Irwin silty clay loam with approximately 15% slope. Sixty-four, 12 X 12 meter plots are arranged in a split-split design to measure burning, mowing, and fertilization effects.

Frequency of Sampling:

Once per year, in the fall, every five years.

Variable Measured:

Unless otherwise noted, the methods were used in measuring the variables listed below follow the procedures in "Recommended Chemical Test Procedures for the North Central Region", Bulletin 499, North Dakota Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota (1980).

1. Nitrate and Exchangeable NR+ 4. A 10:1 mixture of 2 M KCl and soil are shaken for one hour and filtered. Nitrate and ammonium are measured using Technicon Autoanalyzer.
2. Available P (Bray).
3. Total-N (Kjeldahl).
4. pH (1:1 water)
5. Organic matter
6. Exchangeable K, Ca, Mg; Cation Exchange Capacity. Five grams of soil are suspended in 50 mL of 1 M NH₄OAc for 25 minutes, centrifuged, and filtered. This process is repeated three times. The suspension is washed with ethanol, centrifuged, and finally extracted with 2 M KCl. Exchangeable K, Ca, and Mg are determined in the original ammonium acetate washings, and CEC determined by measuring the residual NH₄ in the KCl extract.
7. DTPA-Extractable Cu, Zn, Mn, and Fe.

Methods:

To avoid destructive over-sampling, all scientists on the Belowground Plots use the same samples. A composite of several 5 cm cores are taken from each plot, and sub-samples distributed to each investigator. A 50 g sub-sample is generally plenty for soil chemical analysis. Samples are air dried, ground to pass a 2 mm sieve, and stored in plastic containers for future analyses.

NBP01

Title: Nitrogen and Phosphorus in Bulk Precipitation at Konza Prairie

Purpose: To measure the chemical composition of bulk precipitation inputs.

Date data commenced: 03/19/1982

Date data terminated: 12/31/2021

Location of Sampling Stations:

Bulk precipitation (BP) is collected at four sites (R20B, N01B, 020B, and HQ). Grid locations N-31, N-22, N-30 and C-16, respectively.

Frequency of Sampling:

Samples are collected as soon as possible after each rain event (or when there has been an accumulation of at least 4 mm in the on-sight rain gauges after a number of small precipitation events) during the period May 1 to October 31. During the winter, collections are less frequent, depending upon the freeze-thaw patterns.

Variable Measured:

- 1) Amount of precipitation (mm)
- 2) concentration of $\text{NO}_3\text{-N}$ in each sample
- 3) using volume-weighted monthly composite from each site, measured concentrations of $\text{NH}_4\text{-N}$, orthophosphate or soluble reactive phosphate (SRP), total N (TN), and total P (TP).

Methods:

Precipitation amounts (mm) are measured at each site using a standard rain gauge. Bulk precipitation samples for analysis are collected into a single, acid-washed 500 mL polyethylene bottle with a plastic funnel glued into the cap.

After each rain event (> 4mm) precipitation amounts at each site are recorded and BP samples for analysis are returned to the laboratory. Samples are inspected and removed of foreign debris and insects. They are decanted and weighed into acid washed polyethylene bottles and frozen until analysis. Each same is analyzed for $\text{NO}_3\text{-N}$. Monthly, a volume weighted composite is made for each site and subsequently analyzed for $\text{NH}_4\text{-N}$, SRP, and total N, and total P.

Nitrogen and phosphorous nutrient determinations are analyzed on an O.I. Analytical Flow Solution IV (FSIV) instrument. Nitrate, SRP and a simultaneous determinations of TN may be analyzed from a single aliquot by use of a stream splitter. Ammonium determinations are performed as single analytes. A Windows ®- based software program (WINFLOW) purchased with the FSIV allows automation of the analyzer. Regression curve information, graphic display during analyses, and calculated results provide the operator immediate information about samples. At the completion of each run, data files are electronically stored on the instrument's computer and also transferred to offsite backup data storage.

Inorganic Nitrogen (N) and Phosphorus (P) (NO₃-N, NH₄-N, and SRP) are run within one month of sample collection. Standard concentrations range from 0.5 to 250 µg/L NO₃-N, 0.5 to 150 µg/L SRP and 0.5 to 200 µg/L NH₄-N. The concentrations of most stream water samples are found within these ranges of concentrations but may be manually diluted if needed. As these samples are analyzed, they are checked immediately by the Lab Research Assistant (RA) and rerun immediately if values are off. Data are entered by the Lab RA into the Master Excel spreadsheet.

Total N and total P concentrations values are determined in a two-step process, utilizing a Total Persulfate Digestion (modified from J.J. Ameal American Environmental Laboratory, October 1993), followed by simultaneous determinations of nitrate and SRP on FSIV instrument. In general, a series of 8 duplicated standard solutions, a digestion recovery standard (i.e. spike solution: ATP + urea), 4 spiked samples, an oxidizing reagent blank, and 92 samples comprise each digestion run. Dual standards (both NO₃ and SRP) are used, ranging in concentrations from 0 to 2000 µg/L NO₃-N and 0 to 200 µg/L SRP. Pyrex screw-top digestion tubes are used for this procedure using potassium persulfate as the oxidizing agent in an autoclave digestion for 55 minutes at 17 psi. A 3N sodium hydroxide reagent is used in this procedure for maintaining proper pH. Approximately 1 liter of cocktail solution (matches the final chemical composition of samples + reagents) is digested along with samples and used as the carrier solution for the FSIV determinations. Digested samples are then analyzed for NO₃-N and SRP using FSIV instrument. A digestion recovery value is calculated from digestion recovery standards and spiked samples and then applied to all samples to determine corrected TN and TP concentration values.

Summary of All Changes:

When this study was established in 1982, bulk precipitation was collected on four watersheds (001D, 001C, N01B, and N04D). All sampling sites were at lowland positions (on Tully soils) just above stream banks. In 1983 bulk precipitation was limited to three watershed (001C, N01B and N04D). In 1984, bulk precipitation was collected from 001C and N01B through June, with N04D being added in mid-June. An additional site for collection of bulk precipitation at headquarters (HQ) was added in April 1985. Bulk precipitation was moved from N04D to 020B in February of 1992 following the bison introduction.

No preservatives were used in 1982. Phenyl mercuric acetate (PMA) as a preservative was added to samples starting in 1983; its use was discontinued as of June 27, 1994. A stock solution of 1 mg/g PMA was made and 0.5 mL was added to each bulk precipitation collector prior to placement in the field. Because of the toxicity of this preservative, all collections were returned to the laboratory for volume measurements. No PMA-treated samples were disposed of on the prairie.

In 2001, 001C watershed was renamed to R20B.

Changes effective July 2022: As of July 2022, we have discontinued the collection of bulk precipitation chemistry data. Data on wetfall chemistry at the Konza Prairie Biological Station from 1982-present is available through the National Atmospheric Deposition

Program (NADP - <https://nadp.slh.wisc.edu/>). Konza Prairie is listed as site #KS31 in the National Trends Network's database (<https://nadp.slh.wisc.edu/sites/ntn-KS31/>). Additional data on dry deposition and total (wetfall + dryfall) deposition rates of N and S are also available through the CASTNET site (<https://www.epa.gov/castnet/download-data>) using SiteID: KNZ184.

NBS01

Title: Belowground Plot Experiment: Soil water chemistry from Lysimeters

Purpose: To measure $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, $\text{PO}_4\text{-P}$ and organic N and P in soil water from control and N fertilizer plots in Belowground Studies Plots.

Date data commenced: 04/18/1997

Date data terminated: 09/03/1998

Location of Sampling Stations:

HQC on control plots (C) and nitrogen fertilizer plots (N) in Belowground Studies Plots.

Frequency of Sampling:

All collectors were pumped to a vacuum of about ~50 kpa and checked weekly. Annual sampling began at thaw (about 15 March) and continued until the collectors failed to obtain a sufficient volume of soil water (ca. 50 mL/collector). Sampling was re-instituted, however, if sufficient rainfall occurred again to saturate the soil prior to winter freeze-up around 1 December.

Variable Measured:

Volume of soil solution was recorded for each lysimeter and the samples were returned to the laboratory for analysis of $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, $\text{PO}_4\text{-P}$, and sub sample was frozen for analysis of organic N and P.

Methods:

Installation of lysimeter:

1. A 5 cm diameter auger was used to drill a hole to 20 cm.
2. The soil taken out with the auger was carefully removed in the sequence that it was brought up (later, the soil was replaced in reverse sequence to its removal).
3. 100 cc of silica powder (silicon powder 140 mesh and finer - Fisher Scientific) was poured into the hole.
4. 50 mL of distilled H_2O was poured into the hole.
5. The lysimeter was used to mix the silica and water, making a silica-mud paste in the base of the hole.
6. The lysimeter was put into place.
7. An additional 100 cc of silica powder was poured into the hole, around the lysimeter.
8. Soil was carefully dropped into place around the lysimeter. A meter stick was used to tamp and compress the soil.
9. Step 8 was repeated until the space around the lysimeter is filled. Construction of collector.

Collection of sample:

The pinch-clamps were removed to release any remaining vacuum. A collection bottle capped with a stopper fitted as shown for the lysimeters was connected to the tube extending to the bottom of the lysimeter. A hand vacuum pump was connected to the other tube leading from the collection bottle, and the lysimeter was pumped dry. The vacuum was

reapplied to the lysimeter, and the tubing was clamped for another week. Foil was used to cover the lysimeters to reduce temperatures and infrared damage to the lysimeter cap. Further details on how to pump the lysimeter and collect samples are located in Bushnell Rm 209 in the "Copy of Field Notes" file.

Chemical analyses:

Procedures for measuring soil water nitrogen and phosphorus were the same as are used for stream water nitrogen, bulk precipitation nitrogen, and throughfall nitrogen.

NPL01

Title: Litterfall inputs to soil surface in watersheds with different fire treatments

Purpose: To 1) measure the seasonality and mass of litterfall in the two soil series (Tully and Florence) and a hill-slope site on the LTER watersheds and 2) estimate the amount of nitrogen and phosphorus transferred to the soil by this means.

Date data commenced: 07/01/1981

Date data terminated: 12/11/1990

Location of Sampling Stations:

Adjacent to aboveground biomass sampling sites on the following watersheds:

Ungrazed, unburned Florence:	020B (grid N-28)
Ungrazed, unburned Tully:	020B (N-29)
Ungrazed, unburned hill-slope:	020B (N-28)
Ungrazed, annually burned Florence - 2 sites:	001D (R-27)
Ungrazed, annually burned Tully:	001D (S-28)
Ungrazed, annually burned, hill-slope:	001D (S-28)
Ungrazed, annually burned Tully:	001C (N-31)
Grazed, annually burned Tully:	N01B (N/0-23)
Grazed, 4 yr. burn, Tully:	N04D (K/L-23)
Ungrazed, 4 yr. burn Florence:	004B (H-27/28)
Ungrazed, 4 yr. burn Tully:	004B (F-29)
Ungrazed, 4 yr. burn hill-slope:	004B (F-29)

Frequency of Sampling:

Monthly beginning on June 9, 1981 and ending December 11, 1990.

Variable Measured:

Total dry weight of material obtained in litterfall collectors per collecting period and total-N and total-P gram dry weight.

Methods:

At each site, six or either collectors were systematically arranged about 2 m apart along a 15 m transect marked by a steel conduit stake painted red and yellow. The collector was a split 2" PVC pipe (100 cm X 5.6 cm) with screened ends to allow for drainage. Special care was used to empty these troughs. Suspended litter above the traps can function as "rakes" and remove materials from troughs. Conversely the screen ends of the troughs can also act as rakes and remove suspended litter as the traps are pulled and cleaned. The best procedure in cleaning these traps was to pull them straight out (as opposed to at an angle above the soil), and use one hand to shield the top of the troughs from suspended litter. Traps were replaced by inserting the tubes upside-down, and turning the troughs over only when they are in place.

Further details concerning field collection are located in Bushnell Rm 218 in the “Copy of Field Notes” file.

Collection material was dried to constant weight at 70°C. Nitrogen and phosphorus content were determined by digestion in H₂SO₄ followed by calorimetric measurements using a Technicon Autoanalyzer.

History of the Data Set:

Prior to 1983, this data set was designated as (PPL01). In 1982, samples were collected from Tully and Florence soil sites on three watersheds only (020B, 001D, and 004B). In 1982, three additional sites (Tully soil only) were added (N04C, N01D, and 001C). Also, sampling on Florence sites on 001D was expanded to two sites with six collectors each (instead of one site with eight collectors). Interest in litterfall deposition on slopes caused a change in methods in 1987. Six collectors were placed at the established sampling stations and additional stations were located on hill-slopes in watersheds 020B, 004B, and 001D. The sites on N01B, N04D, and 001C each had eight collectors, as before 1987.

NSC01

Title: Chemistry and Physical Characteristics of Soils from Konza LTER Watersheds with different fire and grazing treatments

Purpose: To measure bulk density, soil organic matter, pH, cation exchange capacity, soil cations (Ca⁺⁺, Mg⁺⁺, Na⁺), phosphorous and total Kjeldahl nitrogen of soils at the 12 LTER vegetation sites.

Date data commenced: 10/01/1981

Date data terminated: ongoing

Location of Sampling Stations:

Soils are sampled along the LTER vegetation transects of 26 watersheds. There have been some variations over time, see “Summary of Changes.”

Frequency of Sampling:

Cores were obtained for analysis once from each site during the first week of October 1982. Sites are now scheduled to be sampled in the non-winter seasons of every 5th year. There have been some variations over time, see “Summary of Changes.”

Variable Measured:

Bulk density, pH, cation exchange capacity, concentrations of Ca⁺⁺, Mg⁺⁺, and Na⁺, extractable phosphorous, and total Kjeldahl nitrogen. In 1987, the following additional variables were measured: K, Zn, Cu, Fe, Mn, NH₄-N, and NO₃-N.

Methods:

An Oakfield Soil Sampler, with a coring diameter of 3/4" (19.05 mm) is used to obtain soil. Litter is scraped off of the surface prior to inserting the tube. Soils are sampled to a depth of 5 cm at all sites, and additional samples to a depth of 25 cm are obtained at all Tully soil sites. A composite sample is obtained by taking ten 5 cm cores along each of the vegetation transect and mixing these together in plastic zip-closed bags. Similarly, four 25 cm cores are combined to form a single sample at each Tully site. Occasionally, it is not possible to get all the 25 cm samples. Samples were taken as deeply as possible and notes about actual depths were made on the plastic sampling bag.

All samples were stored at 5-10°C until they could be processed. The samples were sieved through a #5 U.S.A. Standard Testing sieve (4 mm opening). All visible rocks and large root fragments are subsequently removed from the sieved soil. Sorting takes approximately 20 minutes for each composite sample. Sieved soil is returned to the plastic sampling bag and submitted to the K.S.U. Soils Testing Laboratory for chemical analyses. Upon completion of analysis, any remaining soil is returned to KSU Biology for archival storage.

Bulk density data are obtained from the individual cores placed in soil tins. These are air-dried and weighed, sieved (as above) and reweighed, then dried at 105°C and weighed a final time. No chemical analyses are performed on these samples.

Locations of Archived Soil Samples

1982, 1987, 2002, 2010 -Bushnell Annex 121

Other years are missing or were not returned from Soils Testing Lab

Procedures for Chemical:

KSU Soils Testing Laboratory used their standard test procedures. Details about their various procedures may be found through their website: www.agronomy.ksu.edu/soiltesting/

Many of the original methods used may be found in the following reference: 1998.

Recommended Chemical Soil Test Procedures for the North Central Region-North Central Regional Publication No. 221 (revised). University of Missouri Agricultural Experiment Station, Columbia, MO.

Summary of All Changes:

1982 Watersheds: 001c, 001d, 004b, 020b, N01b, N04a, N20b

1987 Watersheds: 001c, 001d, 002c, 002d, 004a, 004b, 004d, 004f, 020b, N01a, N01b, N04d, N20a, N20b. Samples were taken July to September.

1992 Watersheds: 001c, 001d, 002c, 002d, 004a, 004b, 004d, 004f, 004g, 020b, N01b, N02a, N04c (bench), N04d, N20a, N20b, irrigation transect. Samples were taken May to June. Twelve 5cm cores taken at all sites.

1997 Watersheds: 001a, 001c, 001d, 002c, 002d, 004a, 004b, 004f, 020a, 020b, N01a, N02a (N, S and W), N04a (N and S), N04c (bench), N04d, N20a, N20b, irrigation transect. Samples were taken in July. Twelve 5 cm cores taken at all sites

2001 Fire reversal project began. 001a became R20a, 001c became R20b, 020a became R01a and 020d became R01b.

2002 Watersheds: 001d, R01a, R01b, 002c, 002d, 004a, 004b, 004f, 020b, R20a, R20b, N01a, N01b, N02a (N, S and W), N04a, N04c (N and S), N04d, N20a, N20b, irrigation. Samples were taken in September. Slopes are no longer sampled. 5cm cores reduced to 10 per site.

2010 Watersheds: 001d, R01a, R01b, 002c, 002d, 004a, 004b, 004f, 020b, R20a, R20b, N01a, N01b, N04a, N04d, N20a, N20b, irrigation, Texas Hog pasture, 00SA, 00SB, 00SC, C03A, C03B, C03C, C01D. Samples were taken September to October. Texas Hog pasture, 00SA, 00SB, 00SC, C03A, C03B, C03C, C01D are part of the new patch burn study.

2015 Watersheds: Same as 2010

2020: Watersheds from core LTER watersheds: 001d, R01a, R01b, 002c, 002d, 004a, 004b, 004f, 020b, R20a, R20b, N01a, N01b, N04a, N04d, N20a, N20b, irrigation, Texas Hog pasture, 00SA, 00SB, 00SC, C03A, C03B, C03C, C01D. Samples were taken September to October. Texas Hog pasture, 00SA, 00SB, 00SC, C03A, C03B, C03C, C01D are part of the new patch burn study. In 2020, some data in the watershed column, for example, '1Ai' or

'4Aa' - '1 and 4' are for 1-31 plot number, A is for 'a, b, c, d' the new transect, 'i ' is for irrigation treatment, 'a' is for the ambient, and so on.

2025 Watersheds: All the same watersheds except irrigation (WAT016). The irrigation transects ended in 2023.

NSW01

Title: Soil Water Chemistry from porous cup lysimeters on watersheds with different fire treatments

Purpose: To measure NO₃, NH₄ and organic-N in soil water collected at two depths (20 cm and 80 cm) using porous cup lysimeters.

Date data commenced: 03/01/1982

Date data terminated: 12/01/1990

Location of Sampling Stations:

Lysimeters were installed on one sampling site on each of the following four watersheds in March of 1982: 001C, 001D, N01B, and N04D. In October of 1982, additional sites on 020B and 004B were established. All sites were in Tully soil, about 10-20 m from main stream channels. Each site had five porous cup lysimeter collectors buried to a depth of 20 cm and four collectors buried at a depth of 80 cm. Lysimeters were spaced ca. 3 m apart. This study was terminated in fall 1990 and the lysimeters were removed.

Frequency of Sampling:

All collectors were pumped to a vacuum of about -60 kpa and checked weekly. Annual sampling began at thaw (about 15 March) and continued until the collectors failed to obtain a sufficient volume of soil water (ca. 50 mL/collector). Sampling was re-instituted, however, if sufficient rainfall occurred again to saturate the soil prior to winter freeze-up around 1 December.

Variable Measured:

Volume of soil solution was recorded for each lysimeter and the samples were returned to the laboratory for analysis of NO₃ concentrations in individual samples. Concentrations of organic-N, organic-P, and phosphate were determined on composite samples, prepared by volume-weighing the individual samples into a single monthly composite.

Methods:

Installation of lysimeter:

1. A 5 cm diameter auger was used to drill a hole to a 20 cm or 80 cm depth.
2. The soil taken out with the auger was carefully removed in the sequence that it was brought up (later, the soil was replaced in reverse sequence to its removal).
3. 100 cc of silica powder (silicon powder 140 mesh and finer - Fisher Scientific) was poured into the hole.
4. 50 mL of distilled H₂O was poured into the hole.
5. The lysimeter was used to mix the silica and water, making a silica-mud paste in the base of the hole.
6. The lysimeter was put into place.
7. An additional 100 cc of silica powder was poured into the hole, around the lysimeter.
8. Soil was carefully dropped into place around the lysimeter. A meter stick was used to tamp and compress the soil.

9. Step 8 was repeated until the space around the lysimeter is filled. Construction of collector.

Collection of sample:

The pinch-clamps were removed to release any remaining vacuum. A collection bottle capped with a stopper fitted as shown for the lysimeters was connected to the tube extending to the bottom of the lysimeter. A hand vacuum pump was connected to the other tube leading from the collection bottle, and the lysimeter was pumped dry. The vacuum was reapplied to the lysimeter, and the tubing was clamped for another week. Foil was used to cover the lysimeters to reduce temperatures and infrared damage to the lysimeter cap.

Further details on how to pump the lysimeter and collect samples are located in Bushnell Rm 209 in the "Copy of Field Notes" file.

Chemical analyses:

Procedures for measuring soil water nitrogen and phosphorus were the same as are used for stream water nitrogen, bulk precipitation nitrogen, and throughfall nitrogen.

Summary of All Changes:

Methods of chemical analysis were modified in 1984. Samples collected in 1982-83 were analyzed according to these methods:

Sample preparation and digestion:

Technicon BD-40 and AAI and TKP procedures modified to include $\text{NO}_3\text{-N}$ in Kjeldahl N.

N stock standard:

500 ppm N. – 0.1768 gm $(\text{NH}_4)_2\text{SO}_4$ digested and diluted same as samples.
Working standards made by diluting 500 ppm with black digestion solution.

Reagents:

H_2SO_4 – Salicylic acid mixture: Dissolve 75 g salicylic acid in 19# bottle.

$\text{Na}_2\text{S}_2\text{O}_3$

Catalyst – 100 g K_2SO_4 , 10 g $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, 1 g selenium metal powder.

Digestion:

0.5 soil (weighed 0.5000 g)

+2-3 Hengar porcelain chips

+10 mL H_2SO_4 – salicylic mixture

Mix on vortex mixer

Allow to stand at least 2 hours

Add ≈ 0.6 g $\text{Na}_2\text{S}_2\text{O}_3$

Mix on vortex

Allow to stand overnight

Digest for one hour on 180°C

Continue until temperature reaches 380°C , remove, cool

Add ≈ 4.5 g catalyst, mix

Continue digesting at 400°C for 3-1/2 hours
Remove, cool for about 15 minutes
Add deionized water, cool to room temperature, bring to 75 mL
Mix well by stoppering and inverting tubes, bottle
Run total-N on AA II (Technicon)

NTF01

Title: Volume and Chemistry of Throughfall in tallgrass prairie

Purpose: To measure the volume and nutrient content of water (throughfall) actually reaching the surface of the prairie soil, in order to calculate net fluxes of nutrients through the prairie vegetation and net nutrient input to the prairie soil.

Date data commenced: 03/19/1982

Date data terminated: 10/17/1995

Location of Sampling Stations:

When this study was established in 1982, bulk precipitation and throughfall samples were collected on four watersheds 001D, 001C, N01B, and N04D). All sampling sites were lowland positions (on Tully soils) just above stream banks. Beginning in 1983, throughfall collectors were placed on only two of these watershed (001C and N04D). In 1983 bulk precipitation was limited to three watershed (001C, N01B and N04D). In 1984, bulk precipitation was collected from 001C and N01B through June, with N04D being added in mid-June. An additional site for collection of bulk precipitation at headquarters (HQ) was added in April 1984. Bulk precipitation and throughfall collectors were moved from N04D to 020B in February of 1992 following the bison introduction. Throughfall collection was discontinued after 1995, but bulk precipitation continues to be collected at four sites (001C, N01B, 020B, and HQ).

Frequency of Sampling:

Samples are collected as soon as possible after each rain event (or when there has been an accumulation of at least 4 mm in the on-sight rain gauges after a number of small precipitation events) during the period May 1 to October 31. During the winter, collections are less frequent, depending upon the freeze-thaw patterns. Throughfall collectors were removed prior to scheduled fires, and not replaced until the grass was high enough to influence throughfall volumes and chemistry.

Variable Measured:

Total sample volume of throughfall or precipitation collected is recorded for each sample, and concentration of NO_3 are measured in each sample collected. Since January 1986, NH_4 , organic-N and -P and ortho-phosphate are analyzed in composite samples created by volume-weighting individual samples into a single monthly composite sample for each collector. Prior to 1986, these variables were measured in individual samples. Throughfall measurements were discontinued after the growing season of 1995, but measurements of bulk precipitation chemistry are ongoing.

Methods:

Throughfall collectors are either 5 x 100 cm V-notch stainless steel troughs or 5.6 x 100 cm split PVC pipe (as of 1988, all troughs in use are stainless steel). All troughs have a drainage tube at one end which is fitted with Tygon tubing to transfer canopy leachates into a 4 L collecting jug. Prior to 1984, nylon mesh filters (0.05 mm mesh) prevented most

particulates from entering the collecting jugs. However, the mesh filters tended to become clogged and were not used after 1983.

Since 1984, phenylmercuric acetate (PMA) was used to inhibit microbial activity in collecting jugs. A stock solution of 1 mg/g PMA was made and 0.5 mL is added to each bulk precipitation collector prior to placement in the field. One mL of PMA solution is added to each throughfall collector. Because of the toxicity of this preservative, all collections are returned to the laboratory for volume measurements. No PMA-treated samples are disposed of on the prairie.

Further details explaining field collection are located in Bushnell Rm 218 in the "Copy of Field Notes" file.

Troughs for throughfall collections are located on gradual slopes with the collecting jugs downhill from the troughs. Prior to 1984, each site had four stainless steel and four PVC troughs. From 1984-1995, each site being used of throughfall collections was instrumented with six troughs, all stainless steel. Considerable physical damage to troughs and tubing resulted from rodent activities. These creatures even occasionally defecated and urinated in the troughs despite naphthalene crystals being placed at each trough. The use of naphthalene crystals was discontinued in 1984.

Prior to 1984, the volume of throughfall obtained from each collector was measured in the field using a graduated cylinder, and then the samples were returned to the laboratory for chemical analyses. It was sometimes necessary to composite samples across watersheds in order to obtain enough material for chemical analysis. Since initiating use of PMA as a preservative in 1984, all collecting jugs are returned to lab for volume determinations.

Each site used for bulk precipitation collection has a single bulk precipitation collector (plastic funnels glued into the caps of polyethylene collection jars). Bulk precipitation collectors are used to collect samples for chemical analysis, but not for precipitation volume measurement. Instead, volumes for calculating precipitation inputs are determined using rain gauges located at each sampling site. In addition, a sub-sample of precipitation from the NADP wetfall collector at headquarters (see dataset ANA01) has been routinely analyzed "in-house" since early spring of 1983. These samples allow us to compare our numbers (and analytical procedures with those provided by the NADP laboratory and also allow us to compare nitrogen inputs in wetfall versus those in bulk precipitation. The difference in concentrations of nitrogen in these two types of samples allows us to estimate nitrogen inputs from dryfall.

Summary of All Changes:

In 1982, throughfall was measured on four watersheds (001D, 001C, N01D, and N04D). Each site had one rain gauge, one bulk precipitation collector, and eight throughfall collectors (four collectors made of PVC and four collectors made of stainless steel). Fifty-micron mesh screens were used to keep particulate material out of collection jugs. No preservatives were used in 1982. Beginning in 1983, throughfall collectors were placed on only two watersheds (001C and N04D), and bulk precipitation was limited to three watersheds (001C, N01B and N04D). In 1984, bulk precipitation was collected from only

001C and N01B through June, with N04D being added in mid-June. An additional site for collection of bulk precipitation at headquarters was added in April 1985. Bulk precipitation and throughfall collectors were moved from N04D to 020B on February 20, 1992, following the introduction of bison into Phase II. For throughfall collections after 1983, each site was instrumented with six stainless steel collectors (PVC collectors were discontinued due to rodent damage). Throughfall measurements were discontinued following the 1995 growing season, although bulk precipitation samples continue to be collected at four sites (001C, N01B, 020B and HQ).

Phenyl mercuric acetate (PMA) as a preservative was added to samples starting in 1983; its use was discontinued as of June 27, 1994. Samples collected in 1982-1983 were analyzed according to the methods:

Sample preparation and digestion:

Technicon BD-40 and AAII and TKP procedures modified to include $\text{NO}_3\text{-N}$ in Kjeldah N.

N stock standard:

500 ppm N. – 0.1768 gm $(\text{NH}_4)_2\text{SO}_4$ digested and diluted same as samples.
Working standards made by diluting 500 ppm with blank digestion solution.

Reagents:

H_2SO_4 – Salicylic acid mixture: Dissolve 74 g salicylic acid in 19# bottle
 $\text{Na}_2\text{S}_2\text{O}_3$
Catalyst – 100 g K_2SO_4 10 g $\text{CnSO}_4 \cdot 5\text{H}_2\text{O}$, 1 g selenium metal powder

Digestion:

0.5 g soil (weighed 0.5000 g)
+2-3 Hengar porcelain chips
+10 mL H_2SO_4 – salicylic mixture
Mix on vortex mixer
Allow to stand at least 2 hours
Add ≈ 0.6 g $\text{Na}_2\text{S}_2\text{O}_3$
Mix on vortex
Allow to stand overnight
Digest for one hour on 180°C
Continue until temperature reaches 380°C , remove, cool
Add ≈ 4.5 g catalyst, mix
Continue digesting at 400°C for 3-1/2 hours
Remove, cool for about 15 minutes
Add deionized water, cool to room temperature, bring to 75 mL
Mix well by stoppering and inverting tubes, bottle
Run total-N on AAII (Technicon)

NWC01

Title: Stream Water Chemistry for the King's Creek and Shane Creek Drainage Basin on Konza Prairie

Purpose: To determine the effects of fire frequency on both baseflow and stormflow concentrations of nitrogen and phosphorus.

Date data commenced: 04/01/1983

Date data terminated: ongoing

Location of Sampling Stations:

Swede Creek Quadrangle (USGS) = NE1/4, NE1/4, NE1/4, W1/2, Sec 19, T11S, R8E

N01B flume: (N-22)

N02B flume: (N-21)

N04D flume: (L-22)

N20B flume: (N-22)

Edler Spring (EDLR): D-16 (fall and winter) or D-15 (spring & summer)

Hiking Trail (HIKX): D-13

Hokanson Homestead (HOKN): H-15

North Fork Kings Creek (NFKC): 1-16

South Fork Kings Creek (SFKC): 1-16

Shane Creek (SHAN): T-9

K20, K2 AL (K2AL-1, K2AL-2)

Frequency of Sampling:

If stream locations other than Edler Spring and hiking trail have flowing water, base flow samples are collected 3 times per week in the mornings. Edler Spring and hiking trail are sampled once per week when other sites are dry or have standing water. If the base flow collection time corresponds to a storm flow event, they are classified as such.

Variables Measured:

NO₃ -N + NO₂ -N, NH₄ -N, total nitrogen (TN), soluble reactive phosphate (SRP), total phosphorus (TP), and dissolved organic carbon (DOC).

Field Methods:

Samples (250 mL) from mid-stream are collected up to 3 times per week. Date, time of day (CST), stream temperature (°C) and stream height (N01B, N02B, N04D, and N20B only) are recorded.

Sub-samples (three 20 mL vials) are taken upon returning to the lab. Samples are immediately frozen.

Laboratory Methods:

One vial is analyzed for inorganic nitrogen (N) and phosphorous (P). A second vial is run for dissolved organic carbon (DOC). The third vial is run for TN, and TP. At the completion of all analyses the vial with the maximum volume is frozen as an archived sample for 10

years from date of collection. Nitrogen and phosphorus nutrients are performed by colorimetric determination on a flow solution analyzer. Dissolved organic carbon is measured by high temperature combustion. Data is compiled annually, checked by the RA, and archived by the IM. Laboratory N and P analyses are verified bi-annually via shared sample analysis of USGS Standard Reference Sample. <http://bqs.usgs.gov/srs/>

Summary of Changes:

May 5, 1994: Hokanson (HOKN), Edler Spring (ES) and Hiking Trail (HT) were added. Prior to this only N01b, N02b, N04d, and N20b were sampled.

October 7, 1996: 4 tubes site added. Terminated September 13, 2006.

January 30, 1998: Corral sample added. Terminated March 2, 1998.

March 2, 1998: Konza Falls (KZ falls) added. Terminated August 16, 1998. Part of the LINZ study area.

January 6, 1999: North fork Kings Creek (NFKC) and South fork Kings Creek (SFKC) added to compare bison grazed (SFKC) and not grazed (NFKC) sections of watershed

February 1, 1999: Stone Creek (STCK) added. Terminated on July 5, 2000.

February 8, 1999: dead bison calf next to N04d site. On January 10, 1999 we started sampling upstream from the carcass. Continued sampling at “normal” site also. Terminated “up” sample on March 17, 1999.

2005: During the late spring to early fall months, ES is sampled at the artificial stream site. All flow from ES origin (also known as ES-H) is diverted to this artificial stream project. When sample is taken at the artificial stream it is called ES-F.

2009: Initiate sampling on Shane; Cattle first added to patch burn in Shane above sampling site every spring starting 2011.

Winter 2008/2009: Unknown damaged to the underground pipe that feeds ES-F. When flow is initiated for sampling it is very dirty; large dirt particles. ES-F is allowed to flow for a minimum of 5 minutes before sampling.

Winter 2010: N2B woody riparian removal on whole channel. Every winter since, crews return to cut regrowth. Most years 1/3 to 1/2 of drainage is re-cleared. The following year, crews concentrate on the areas not treated the previous year.

March 2018: Edler Spring (EDLR) sample is taken directly at spring box. Flow is so low that water does not make it to the ES horse tank. Often the sample has large (<1mm) dirt chunks and/or plant material. Spring box is not sealed.

2018: K2AL-1 and K2AL-2 sites added. K20 vegetation removal started in 2018. K2AL-1 is below and K2AL-2 is above the confluence with the small stream draining K20 into the North Branch of Kings Creek.

2019: TN data from 2001-2018 available upon request.

2021: DOC data from 2021, we replaced to a new DOC analyzer (Shimadzu TOC-L CSH), the old DOC analyzer (Shimadzu TOC-L CPH).

NWC02

Title: Stream Water Conductivity for the King's Creek drainage basin on Konza Prairie

Purpose: To determine the effects of fire frequency on both baseflow and stormflow concentrations of nitrogen and phosphorus.

Date data commenced: 04/01/1983

Date data terminated: 06/21/1993

Location of Sampling Stations:

Swede Creek Quadrangle (USGS) = NE1/4, NE1/4, NE1/4, W1/2, Sec 19, T11S, R8E

N01B flume: (N-22)

N02B flume: (N-21)

N04D flume: (L-22)

N20B flume: (N-22)

Shane Creek (SHAN): T-9

Frequency of Sampling:

If stream locations other than Edler Spring and hiking trail have flowing water, base flow samples are collected 3 times per week in the mornings. Edler Spring and hiking trail are sampled once per week when other sites are dry or have standing water. If the base flow collection time corresponds to a storm flow event, they are classified as such.

Variable Measured:

NO₃ -N + NO₂ -N, NH₄ -N, total nitrogen (TN), soluble reactive phosphate (SRP), total phosphorus (TP), and dissolved organic carbon (DOC).

Methods:

One vial is analyzed for inorganic nitrogen (N) and phosphorous (P). A second vial is run for dissolved organic carbon (DOC). The third vial is run for TN, and TP. At the completion of all analyses the vial with the maximum volume is frozen as an archived sample for 10 years from date of collection. Nitrogen and phosphorus nutrients are performed by colorimetric determination on a flow solution analyzer. Dissolved organic carbon is measured by high temperature combustion. Data is compiled annually, checked by the RA, and archived by the IM.

Producer Data

PAB0_1

Title: Aboveground net primary productivity of tallgrass prairie based on accumulated plant biomass on core LTER watersheds (001d, 004b, 020b)

Purpose: To assess the total aboveground biomass per unit area and separate the total into live (includes grass, sedges and current year's dead), forb, woody and previous years' dead (p. dead) components; and determine N and P content of aboveground foliage on treatment plots burned annually, every 2 years, every 4 years, unburned and seasonally (spring, summer, fall, winter). This data set is separated into the following sub-sets:

PAB011 - end-of-season clips on core watersheds: 001D, 004B and 020B PAB021 - bi-weekly clips on 001A, 020A, 001C, and 020D

PAB031 - end-of-season clips on seasonal watershed: 0SpA, 0SpB, 0FA, 0FB, 0WA 0WB, 0SuA, and 0SuB

PAB041 - end-of-season clips on non-core watershed: 002C, 002D and 004A

PAB051 - end-of-season clips on fire reversal watersheds: R01A, R01B, R20A and R20B.

Date data commenced: 04/01/1984

Date data terminated: ongoing

Location of Sampling Stations:

PAB011, PAB031, PAB041, PAB051: The above-ground biomass is harvested adjacent to the species composition plots in LTER watersheds 001D, R01A, R01B, 002C, 002D, 004A, 004B, 020B, R20A, R20B, 0SpA, 0SpB, 0SuA, 0SuB, 00FA, 00FB, 00WA and 00WB on Tully and Florence soils. Exceptions are 002C and 002D—Florence soils only. R01A and R20A—Tully soils only. A 50 meter line for aboveground biomass is located 3 m to the side of each species composition line. Side clipped varies from year to year—N and/or W then S and/or E the following year.

PAB021: R01A (previously 020A), R01B (020D), R20A (001A) and R20B (001C). The location of the “summer clips” was separate from the “end of season” clips. All sites were on lowland soils (Irwin or Tully).

Frequency of Sampling:

PAB011, PAB041 and PAB051: The LTER watersheds are harvested in autumn (late Aug to Oct) when it is estimated that peak biomass has occurred.

PAB021: 1984 to 2000: Watersheds were harvested every two weeks from approximately May 15 until mid- September. A total of 10 clips were made over the growing season. The bi-weekly or “summer clips” were separate from the “end of season” clips.

PAB031: 0SpA, 0Spb, 00FA, 00FB, 00WA, and 00WB are harvested in autumn (late Aug to Oct) when it is estimated that peak biomass has occurred. In the years when 0SuA and

0SuB are burned, they will be clipped twice; once prior to burning (mid to late July) and again in late October after a frost.

Variable Measured:

Total aboveground biomass per unit area. Prairie vegetation is separated into live, forb, woody and p. dead. Currently, only samples 1-3 for watersheds 001D, 004B, and 020B are ground and saved for determining percent N and P in foliage in live grass, forb, woody, and p. dead. Prior to 1999, all PAB samples were ground and saved for chemical analysis (PAB0_2).

Field Methods for PAB011, PAB031, PAB041 and PAB051:

Each LTER watershed has 4 transects per soil type (Florence and Tully). For each transect, five 0.1 m² (50cm x 20cm) quadrats are clipped. The clips are done parallel to the species composition transects; 3 m away. Side clipped varies from year to year—N and/or W one year and S and/or E the next. All biomass is clipped to ground level. A quick sort of all the major plant types: grass (live grass, sedges, and current year's dead), forb, woody and previous years' dead (p.dead) is done at the time of clipping. Each type goes into a separate pre-labeled bag.

For unburned sites, p. dead must be removed first. Following the edges of the clipping frame, cut through all the levels of litter avoiding live grass, forb and woody. Gently comb out the p. dead material and bag. Then collect remaining parts of sample. All material is dried at 60°C for 2-3 days.

Field Research Assistant has the maps of all clipping locations. Please note that while some of the maps indicate a specific 1-5 position, for clipping purposes this is not adhered to in the field.

Field Methods for PAB021 (bi-weekly or summer clips):

1984 to 2000: Watershed 001A (now R20A) and 020A (now R01A) were harvested every two weeks from approximately May 15 until September 15; 10 clips total. 001C (now R20B) and 020D (now R01B) were also clipped every two weeks in 1999 and 2000. The location of the "summer clips" was separate from the "end of season" clips. All sites were on lowland soils (Irwin or Tully). At the beginning of the growing season, an area was marked off for these clips with flags. Each flag was approximately 10 m from the next in a straight line numbered 1 to 20. The clipping line was parallel to the fireguard. Beginning on or near May 15 the first clip was done at the flags. Two weeks later, technicians returned to the site, took one step to the south, clipped another sample and marked it with a flag. The final clip (#10) was on or near September 15. The flags would remain over the winter and when the plots were laid out the following year, the new line would be located several paces west (for 020A and 001C) or east (for 001A and 020D) of the previous year's location. Once the new line was in place, the old flags were removed. A relatively large area was set aside for these clips; enough that the same area was not revisited for at least 5 years.

Laboratory Methods: Sorting of the Vegetation for all PAB0_1 categories

In the lab, samples are "cleaned up". Burned samples are fully sorted to grass, forb and woody. Unburned bags are fully sorted to grass, forb, woody and p. dead. Dirt, roots, rocks and other debris are removed. Samples will be re-dried at 60°C for 24-hours prior to weighing. As of 1999, samples 1, 2 and 3 of 001D, 004B and 020B (PAB011) are retained

for chemical analysis. All other samples (PAB031, PAB041, PAB051) are discarded. PAB021 was sorted the same as all other PAB0_1 samples. All samples were retained for chemical analysis.

Chemical Analysis of PAB0_1 Samples:

To determine N and P; 20-30 grams of each tissue category, live, forb, current year's dead (until 2001) and p. dead, are ground through a Wiley mill using a 40 mesh screen. Samples that are too small for the Wiley are mechanically pulverized with steel rods or ball bearings. Samples are dried for 48 hours at 70°C and approximately 0.5000 g (to the nearest 0.0001 g) is weighed into pyrex digest tubes. Nitrogen and phosphorous content are determined by Kjeldahl digestion in concentrated sulfuric acid (H₂SO₄) followed by calorimetric measurements using a Technican auto-analyzer. We correct the data for incomplete recovery on the basis of pine needle standard reference material values. Data stored as percent N and P where: % N and P = ppm * cf (correction factor), cf = observed of 2° standards/literature value.

PAB011: currently, only samples 1, 2 and 3 are archived. Prior to 1999, all 5 samples were retained.

PAB021: all samples are archived

PAB031: samples are archived from 1994 to 1999. PAB041: samples prior to 1999 are archived. PAB051: samples prior to 1999 are archived.

- Chemical analysis data only exists for years 85-88 and 90-93. These years contain the combined data from all watersheds which were active at that time. Accuracy of data is unknown and can be made available upon request.

Summary of All Changes:

1991: End-of-season biomass samples from 1991 were sorted only into grass, forb, and previous dead (where applicable) categories. Due to an extensive wildfire in spring 1991, most watersheds had no litter accumulation, and "grass" in 1991 included live grass + current year's dead grass (no separation due to the large number of additional areas sampled that year and the need to process samples quickly). The April wildfire burned watersheds 001C, 001D, N01B, N01A, 004B, N04D, 020B, N20B, N20A, 002D.

Prior to 1992: (for all PAB0_1) Woody plants were NOT separated from forbs. The most common woody species are: *Amorpha canescens* (lead plant), *Ceanothus herbaceus* (New Jersey tea), *Cornus drummondii* (dogwood), *Rosa arkansana* (wild rose), *Rhus glabra* (Smooth sumac), and *Symphoricarpos orbiculatus* (buckbrush).

1994: seasonal burning began (PAB031). Prior to this all burning was done in the spring only.

1994 and 1995: (PAB021) 020A was burned in a wildfire. 010B was clipped for two years to account for the p.dead component.

1997: Watersheds 001A, 020A, 020D, 001C were set up to become part of the Fire Reversal Experiment (PAB051). Fire Reversal did not take place until 2001.

Watersheds 001A and 020A (Tully soils only) began being clipped at the end of the season as part of PAB051 and continued to be clipped biweekly throughout the summer as part of PAB021.

Before 1999: All PAB0_1 samples were ground and saved for future chemical analysis. Currently, only 001D, 004B and 020B (PAB011) samples 1, 2 and 3 are ground and saved.

1999: Watersheds 020D and 001C began being clipped biweekly as part of PAB021. They also continued to be clipped at the end of the season as part of PAB051.

2000: PAB021 was terminated after the 2000 clip season.

2001: Fire reversal experiment (PAB051) began. R01A was 020A, R20A was 001A, R01B was 020D, and R20B was 001C.

2002: clipping on slope locations terminated for all PAB0_1.

Prior to 2002: current year's dead (c.dead) was separated from live grass for all PAB0_1. After this time c.dead is included in live grass weights.

2024: a small sub-set of samples were incorrectly archived. The impacted samples were predominantly of the woody category. These samples were exceptionally large and should have been archived in the unground state. Through a misunderstanding, the student ground only the leaves and small branches. The stems (larger than a pencil) were thrown away because they were too big for the Wiley mill. Impacted samples: 4b-ta-#1, 4b-tb-#1, 4b-td-#1, 4b-td-#3, and 20b-td-#2. This might have also impacted some p.dead samples: 4b-tb-#1, 4b-tc-#2, 20b-fd-#2, 20b-tb-#1, and 20b-td-#2. These samples might have contained larger forb or woody stems that were deemed too large for the Wiley mill.

PBB01

Title: Belowground Plot Experiment: Aboveground net primary productivity of tallgrass prairie based on accumulated plant biomass

Purpose: To monitor long-term changes in plant production and nutrient balance due to the effect of annual burning (late April-early May), mowing (late June; stopped 2003), and nitrogen (10gN/m^2) and phosphorus (1gP/m^2) fertilization (late May-early June).

Date data commenced: 11/15/1986

Date data terminated: ongoing

Location of Sampling Stations:

HQC

Frequency of Sampling:

Once per year for peak biomass in September to October.

Variables Measured:

1. Plant biomass sorted by grass, forb, woody and p.dead. (PBB011)
2. Total-N and total-P (PBB012)

Methods:

Field and lab methods are identical to those for PAB01 except two 0.1m^2 quadrats are clipped from each plot. The plant material is dried at 60°C and then separated into grass, forb, woody and p.dead material. The samples are then dried again at 60°C and weighed. Samples are no longer kept for analysis.

Summary of All Changes:

Prior to 1992, only one 0.1m^2 quadrat per plot was clipped.

As of 2000, all samples are discarded. Prior to this, all samples were kept and ground to pass a 2 mm screen and acid digested by the Kjeldahl procedure and the solution analyzed for total-N and total-P by automated calorimetric analysis. (PBB012).

As of 2000, samples are no longer ground and archived for nutrient analysis. Samples from 1987-1993 were analyzed for N and P concentrations, and data are archived as KNZ dataset PBB012. Ground plant samples from 1987-2000 are archived for additional future analyses, as needed.

2002- c.dead no longer separated from live grass.

Before 2004, there was a mowing treatment for half of the plots. Mowed plots were clipped in mid- to late-June before mowing; then mowed to a height of 4 inches. All clippings were removed. The mowed plots were clipped again at time of peak biomass; same date as un-mowed.

June 2004 - irrigation cistern collapsed during repairs (located uphill from plots 33-44). Huge flood and rock debris; debris was removed within 2 days of “damage”.

May 2, 2006 - damage to middle section of plot #44 and a small part on east side of #43. There was a bentonite spill during the installation of two seismograph wells on the hill above these plots. An attempt was made to clean up the area. Damaged area was delineated by flags and avoided during clipping for 2 years.

2017 – fertilizer treatments have ended.

PBB02

Title: Belowground Plot Experiment: Biomass and nutrient content of Rhizomes

Purpose: Monitor long-term changes in plant root production and nutrient balance due to the effect of annual burning, mowing, and nitrogen and phosphorus fertilization.

Date data commenced: 11/15/1986

Date data terminated: 10/10/1994

Location of Sampling Stations:

HQC

Frequency of Sampling:

Once every five years in August or September.

Variable Measured:

1. Root biomass sorted by live, dead, or forbs
2. Total-N and total-P

Methods:

Two 5 cm diameter by 20 cm deep soil cores are sampled from each plot and combined. The roots are then washed, separated, and dried at 60°C. The dried material is then ground to pass a 2 mm screen and acid digested by the Kjeldahl procedure. The solution is then analyzed for total-N and total-P by automated calorimetric analysis.

PBB03

Title: Belowground Plot Experiment: Biomass and nutrient content of Roots

Purpose: To determine the N and P content on live and dead grass roots.

Date data commenced: 11/15/1986

Date data terminated: 11/14/1994

Location of Sampling Stations: HQ

Frequency of Sampling: Late summer, every 5 years

Variable Measured: location, plot number, mass of live root, nitrogen percentage of live root, phosphorous percentage of live root, mass of dead root, nitrogen percentage of dead root, phosphorus percentage of dead root, mass of live forbs, nitrogen percentage of live forbs, phosphorous percentage of live forbs

Methods:

Standing crops of live and dead grass roots (0.1 sq. m² * 20cm deep samples) are taken in late summer every 5 years from 64 below ground plots. N&P content are determined on live and dead grass roots. N&P for forb roots are available for some plots in some year.

PEB01

Title: Aboveground net primary productivity of tallgrass prairie based on accumulated plant biomass in grazing enclosures on bison-grazed watersheds

Purpose: To determine long-term effects of bison grazing on aboveground primary production.

Date data commenced: 08/20/1992

Date data terminated: ongoing

Location of Sampling Stations:

There are four exclosures on Florence soils and four exclosures on Tully soils in each of the following grazed watersheds: N01a, N01b, N04a, N04d (total= 32). Exclosures in N01a and N04a were erected in March, 1988 and were first sampled in 1992. Exclosures in N01b and N04d were erected in April, 1992 and were first sampled in 1995.

Frequency of Sampling:

Once per year at peak biomass (September to October).

Variable Measured:

Aboveground biomass of grass, forbs and woody and p.dead.

Methods:

An exclosure is 5 m x 10 m and constructed of fence posts and sturdy cattle paneling. One half (5 m x 5 m) has been designated as the permanently ungrazed treatment; it has not been grazed since 1988 (N01a & N04a) or 1992 (N01b & N04d). It is marked with pink poles. The other half is the grazed section; it is marked with blue poles. Every six years a new grazed area is closed off and animals will not have access to this section for six years. At the end of six years, this section will be reopened to grazing and a new section is closed off. The “grazed” section moves in a clock-wise pattern around the permanently ungrazed section. The “grazed” sections were moved in late spring of 1997, 2004 and 2010.

The “grazed” sections were moved in late spring of 1997, 2004, 2010, and 2016.

Sampling methods are identical to PAB01 except five 0.1 m² plots randomly located within each section, grazed vs. ungrazed; total of 10 samples per exclosure. Grazed and ungrazed sides of the exclosure are clipped at the same time. The plant biomass for each clipped plot is bagged, dried at 60°C and then fully sorted to live (grass), forb, woody and p.dead components. The samples are then dried again at 60°C and weighed. Samples are not kept for further analysis.

Current data sheet is available.

Maps available in Bushnell 207.

Summary of All Changes:

ORIGINAL METHODS: The “grazed” section used to be temporary. It was erected adjacent to the each permanently ungrazed enclosure at the beginning of the growing season and remained in position until peak biomass occurred. The temporary grazed enclosure was removed immediately following clipping.

1992: for all plots “lvgras” = live grass + sedge + current year’s dead

1994: for N04a plots = no previous year’s dead component due to wildfire on 3-31-94

2001: Current year’s dead (c.dead) no longer separated from “live”.

2003: Sample size reduced from nine samples per side (9 ungrazed & 9 grazed) to five per side.

2010: During the 1997 or the 2004 move of the grazed section of pens 5 and 6 (lowland N01a), the UNgrazed section of both enclosures were misidentified. As a result, the two UNgrazed sections were placed next to one another. It is no longer possible to move the grazed section in the same manner as all other pens. To compensate for this “lost” fourth position, it was decided to move the grazed section away from the ungrazed section for this rotation. The UNgrazed section as of 2004 will remain as the permanently ungrazed area. See PEB01 illustration 2.

March 2016: All “grazed” sections were moved.

November – December 2021: Moved all “grazed” sections 90° clock-wise. Installed carabiner clips in one corner to allow for easier and safer entry into pens.

PEC01

Title: Elemental chemistry of plant tissue collected for the Konza LTER aboveground plant biomass on Konza Prairie core watersheds

Purpose: To study elemental chemistry (N, C, H, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, P, Pb, S, Si, Ti, Zn) of dried and ground end-of-season live grasses collected on Tully soils.

Date data commenced: 01/07/1985

Date data terminated: 12/30/2016

Location of Sampling Stations:

001d

Frequency of Sampling:

Annually at the end of the growing season.

Variable Measured:

N, C, H, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, P, Pb, S, Si, Ti, Zn

Methods:

Within plant growth type (grasses, forbs, and woody) and year, elemental concentrations were measured on one pooled (2g) sample containing four (0.5g) subsamples of ground and dried plant tissue (subsamples included from recent years were named TA2, TB2, TC2, and TD2; subsamples included from older years were named: TA2, TA4, TB2, TB4). For more information on plant sampling, see description of the Konza LTER PAB01 aboveground plant biomass dataset. Elemental chemistry was analyzed using combustion analysis for percent N and using hot plate digestion and inductively coupled plasma atomic emission spectroscopy (ICP-AES) for concentrations of metals (ppm) at the Cornell Nutrient Analysis Laboratory (<https://cnal.cals.cornell.edu>).

PFS01

Title: Reproductive effort of Big Bluestem, Indian grass and Little Bluestem on Belowground Plots

Purpose: To assess the effects of burning, mowing and fertilizer treatments upon flowering stem height and density of big bluestem (*Andropogon gerardii*), little bluestem (*A. scoparius*) and Indian grass (*Sorghastrum nutans*), and total vegetation production.

Date data commenced: 07/01/1986

Date data terminated: 10/15/1988

Location of Sampling Stations:

Every treatment plot in the LTER belowground study plots.

Frequency of Sampling:

Production measurements made in July and October; flowering stem measurements made in November.

Variable Measured:

Flowering stem height and density of the three main grass species. Total vegetation production (biomass).

Methods:

Flowering stem height:

Fifteen random points were located within each of the 64 treatment plots. At each sampling point, the flowering stem height for each of the three species nearest the point was measured to the nearest cm.

Flowering stem density:

Ten 50 x 50 cm quadrats are thrown randomly within each treatment. Within each quadrat the number of flowering stems for each of the three species is recorded.

Production:

All vegetation was clipped to ground level in two 20 x 50 cm quadrats per treatment plot. This was carried out in July and October of 1986. The material was sorted in to forb/woody and grass/sedge components, oven dried at 60°C for > 24 hours and weighed. In 1986, the first sample plot was 2 m east and 2 m south of the NE corner of each treatment plot. The second plot was 2 x 2 m farther east and south of the first plot. These coordinates were chosen to coincide with insect and remote sensing sample plots. Since 1987, clipped quadrats were chosen randomly, one per plot, in July and October.

PGL01

Title: Litterfall collection in riparian gallery forest at Konza Prairie

Purpose: To measure annual inputs of macro particulates (particles greater than 1 mm² in size) to the gallery forest floor. The data provide a conservative estimate of net primary production and will therefore measure effects of abiotic (climate) and biotic (e.g., canopy herbivores) factors on forest production.

Date data commenced: 10/06/1981

Date data terminated: ongoing

Location of Sampling Stations:

Litterfall trap placement was determined by a stratified, random design. A line was drawn on a map of the two forks of Kings Creek representing the longest possible straight line through the forest. This line was scaled to the actual length of the forest, and divided into five equal sections. A random number generator was then used to select a point on each segment, and a line perpendicular to the main line was drawn. These perpendicular lines represented the five transect lines used to place litter traps in each fork of Kings Creek. The points where these lines emerged from the forest were located in the field, and a surveyor's transit and compass were used to measure the length of each transect and set stakes at 25 m along the transect lines. Once the total length of the transect lines was known for each forest, the number of traps allocated to each transect line was determined. The number of traps corresponds to the relationship: length of transect/total length of transect in forest x30. The only exception to this procedure was that each transect was assigned a minimum of two litter traps. A random number generator determined the location of each trap. Again, exceptions existed in site selection, and these were 1. Traps were to be separated by a minimum of 5 m, and 2. Traps were to be placed within 10 m of canopy foliage. This last rule was used in placing traps along transects N-1 and N-3.

Frequency of Sampling:

Samples are collected monthly March to December, weather permitting. October and November samples are collected approximately every two weeks. No collections are made during January and February (little to no sample this time of year).

Variable Measured:

Total deposition of litter (grams of dry weight/0.25 m²) per collection period, and subdivisions of wood and seeds (see sample data sheet). Please note that foliage is not measured directly; foliage mass may be determined by subtraction of woody and seeds from total. Insects, feathers and other animal debris and fecal droppings are removed prior to weighing.

Current data sheet attached.

Methods:

Thirty litterfall traps, 50 x 50 cm (.25 m²) are located along the north fork of Kings Creek. Two are located on the south fork of Kings Creek. The north fork boxes are numbered 31 to 60 and the south fork boxes are numbered 1 and 2. Originally, the south fork also had

boxes 3 to 30 but these samplers were terminated in 1993 due to repeated damage by bison. (Boxes 1 and 2 are located just outside the bison area.) The design of the litterfall traps is similar to those used at Coweeta but have been modified overtime. Modifications include increasing the depth of the traps to 50 cm (“deep dish”), reinforcement of all corners and screens (to minimize the effect of rot) and metal legs.

Samples are collected by brushing all material to a corner. The sample is then brushed or scooped into pre-labeled paper bags. Any sample that gets caught on the upper rim of the trap (large branches, etc.), will be marked and cut or broken apart to retain the portion that would be inside the sampling area (the rest is discarded). Samples are dried at 60°C for a minimum of 3 days and weights of woody material, seeds and total are measured.

Summary of All Changes:

FREQUENCY OF SAMPLING (Original set-up; 1981)

Traps were placed in the field on September 4-6, 1981. Collections were made every two weeks during September, October and November and then monthly from December to September. Deviations: In 1983, collections were irregular. Beginning in 1984, the autumn collections were at monthly intervals. And 1987-1992, the monthly collections were from March through November.

VARIABLES MEASURED (1981)

Deviations: Foliage was not measured 1981-June 1992, and 1995-present (foliage mass may be determined by subtraction of wood and seeds from total). Foliage weights were measured July 1992-Dec 1994.

ORIGINAL METHODS (1981)

Sixty litter fall traps, 50 x 50 cm (0.25 m²) were constructed during the summer of 1981. The design of these traps was similar to those used at Coweeta (e.g., Cromack, K. Jr. 1973, Litter production and decomposition in a mixed hardwood watershed and white pine watershed at Coweeta Hydrologic Station, North Carolina. PhD dissertation. University of Georgia, Athens, GA.), except that the depth of these traps was 50 cm. This “deep dish” design was used to prevent losses due to high winds. The traps open at 1 m above the forest floor. Deposition of litter into these traps due to lateral movements by wind is believed minimal (e.g., virtually no foliage was found in these traps during January 1982, in spite of strong winds).

The allocation of 30 traps per forest floor resulted in a somewhat greater sampling intensity of the South Fork of Kings Creek. Transect lines measured 353.6 m resulting in one collector every 11.8 m. The total transect length for the North Fork was 543.3 m resulting in one trap placed every 18.1 m.

The transects are marked by a yellow-painted steel conduit stake at each end. The material is dried at 60°C and weights of woody material, seeds and total are measured. Foliage is assessed by subtracting the woody and seed weights from the total weight.

January 6, 1993: Collections from litter-fall traps within the bison area terminated. The sample ID's affected are 3 through 30, inclusive. This modification is due to repeated damage to litter fall traps by bison.

PGT01

Title: Konza Prairie grass species trait

Purpose: Evolutionary history plays a key role driving patterns of trait variation across plant species. For scaling and modeling purposes, grass species are typically organized into C3 versus C4 plant functional types (PFTs). PFT groupings may obscure important functional differences among species. Rather, grouping grasses by evolutionary lineage may better represent grass functional diversity.

We measured 11 structural and physiological traits in situ from 75 grass species within the North American tallgrass prairie. We tested whether traits differed significantly among photosynthetic pathways or lineages (tribe) in annual and perennial grass species. We hypothesized that tribe would be the best predictor of traits, more so than photosynthetic pathway. We further hypothesized that there would be substantial variation of traits in species among the seven C4 lineages represented at our site.

Date data commenced: 01/01/2020

Date data terminated: 12/31/2020

Research Location:

Sampling occurred throughout the entirety of Konza Prairie Biological Station – there was no specific location for measuring all the species given that we measured naturally established individuals growing within their own viable habitat.

Methods:

Sampling occurred throughout the entirety of the Konza Prairie Biological Station during the summer of 2020. A suite of plant traits was collected for each replicate in coordination with the initiation of flowering for each species. Traits measured include photosynthetic A-Ci response curves (to derive V_{cmax} , J_{max} , and V_{pmax} (for C4 species)), leaf osmotic potential at full turgor (MPa), specific leaf area (SLA; $\text{cm}^2 \text{g}^{-1}$), leaf dry matter content (LDMC), leaf thickness (mm), maximum plant flowering and vegetative heights (cm), leaf C:N, and $\delta^{13}\text{C}$ leaf composition. V_{cmax} is the maximum rate of carboxylation of Rubisco ($\mu\text{mol m}^{-2}\text{s}^{-1}$), J_{max} is the maximum rate of electron transport ($\mu\text{mol electrons m}^{-2}\text{s}^{-1}$), and V_{pmax} is the maximum rate of carboxylation of PEPc ($\mu\text{mol m}^{-2}\text{s}^{-1}$).

Leaf gas exchange was measured with a LI-6400XT Portable Photosynthesis System (LI-COR, Inc., Lincoln, Nebraska, USA), osmotic potential was measured using a VAPRO® Vapor Pressure Osmometer (Model 5600; Logan, Utah, USA). Leaf C and N content and stable C isotopic composition were measured at the Stable Isotope Mass Spectrometry Laboratory at Kansas State University. Maximum flowering height and maximum vegetative height (cm) were measured from the ground to the highest point of the inflorescence or the uppermost leaf, respectively. Leaf area was measured in the field using Leafscan, a mobile app for measuring the surface area of individual leaves. Leaf wet mass was measured after leaf rehydration and leaf dry mass was measured after the leaf had been dried for at least 48 hours at 60 °C. Rehydration was performed by submerging the leaf in

water for 24-72 hours. Leaf thickness was derived from $(SLA * LDMC) - 1$ and multiplied by 10 to convert to mm.

PPH01

Title: Phenology of selected plant species at Konza Prairie

Purpose: To determine annual temporal patterns of growth and reproductive stages of 29 selected species of grasses, forbs, and woody plants characteristic of a variety of habitats.

Date data commenced: 06/13/1981

Date data terminated: 10/31/1998

Species and Locations:

Species selected were 1) dominant, 2) representative of all parts of the growing season, 3) representative of various life form and classification groups (such as C₃ and C₄ plants, grasses, forbs, and woody species), or 4) likely to have potential for indicator uses.

	Florence Soil Burned	Florence Soil Unburned	Tully Soil Burned	Tully Soil Unburned	Rocky Slopes
<u>Andropogon gerardii</u> , big bluestem	+	+	+	+	
<u>Andropogon scoparius</u> , little bluestem	+	+	+	+	
<u>Sorghastrum nutans</u> , indiangrass	+	+	+	+	
<u>Boutelous curtipendula</u> , sideoats grama	+	+	+	+	
<u>Panicum virgatum</u> , switchgrass			+	+	
<u>Dicanthelium oligosanthes</u> var. <u>scribnerianum</u> , scribner panicum	+	+	+	+	
<u>Sporobolus asper</u> var. <u>asper</u> , tall dropseed	+	+			
<u>Sporobolus heterolepis</u> , prairie dropseed					+
<u>Poa pratensis</u> , Kentucky bluegrass		+			
<u>Carex grvida</u> var. <u>lunelliana</u> , heavy sedge	+	+	+	+	
<u>Carex meadii</u> , Mead's sedge	+	+	+	+	
<u>Amorpha canescens</u> , leadplant			+	+	
<u>Astragalus crassicaarpus</u> var. <u>crassicaarpus</u> , groundplum milkvetch					+
<u>Dalea purpurea</u> var. <u>purpurea</u> , purple prairieclover					+
<u>Schrankia nuttalli</u> , catclaw sensitivebriar					+
<u>Aster ericoides</u> , heath aster	+	+	+	+	
<u>Lomatium foeniculaceum</u> var. <u>daucifolium</u> , carrotleaf lomatium	+	+			
<u>Salvia pitcheri</u> , pitcher sage	+	+			
<u>Liatris punctata</u> , dotted gayfeather	+	+			
<u>Solidago missouriensis</u> var. <u>fasciculata</u> , Missouri goldenrod	+	+	+	+	

<u>Cornus drummondii</u> , roughleaf dogwood					+
<u>Baptisia australis</u> var. <u>minor</u> , blue wildindigo	In one site intermixed or close together				
<u>Baptisia bracteata</u> var. <u>glabrescens</u> , plains wildindigo	In one site intermixed or close together				
<u>Tripsacum dactyloides</u> , eastern gamagrass	One site NW of headquarters				
<u>Rhus glabra</u> , smooth sumac	One site				
<u>Agropyron smithii</u> , western wheatgrass	One site, unburned				
<u>Populus deltoides</u> subsp. <u>monilifera</u> , eastern cottonwood	Kings Creek forest				
<u>Celtis occidentalis</u> , common hackberry	Kings Creek forest				
<u>Quercus muehlenbergii</u> , chinquapin oak	Kings Creek forest				

Frequency of Sampling:

Approximately weekly during the growing season, typically early April to late November. Observations begin in mid-June in 1981 and ended on October 31, 1988.

Variable Measured:

Dates of the following stages were recorded:

1. Initiation growth
2. Duration of flowering (anthesis)
3. Fruit mature (fully developed and ripe)
4. Leaves more than 90% dry

Methods:

The phenological condition of the species was grouped into three categories: 0-5%, 5-20%, and greater than 20%.

PPL01

Title: Konza Prairie Long-Term Phosphorus Plots Study

Purpose: To address whether chronic nutrient additions changed community structure and ecosystem productivity of a native tallgrass prairie.

Date data commenced: 05/01/2002

Date data terminated: ongoing

Location of Sampling Stations: Watershed 2C

Frequency of Sampling: Annually

Methods:

Experimental Design:

In 2002, a 30×40 m area was divided into 5×5 m plots arrayed in a contiguous 6×8 plot grid. Starting in 2003, 2 nitrogen (0 and 10 g m^{-2}) and 4 phosphorus (0, 2.5, 5, and 10 g m^{-2}) treatments were applied to the plots in a fully factorial design (8 treatment combinations). There were 6 replicates of each treatment combination resulting a total of 48 plots. Nutrients were added by hand in an even distribution in early June. Nitrogen was added as ammonium nitrate, and phosphorus as superphosphate.

The site is ungrazed by bison and is burned in odd years (2003, 2005, 2007, etc.)

Treatment codes are as follows:

N1P0 - N0-P0,

N1P1 - N0-P2.5,

N1P2 - N0-P5,

N1P3 - N0-P10,

N2P0 - N10-P0,

N2P1 - N10-P2.5,

N2P2 - N10-P5,

N2P3 - N10-P10

Plant community composition:

Within each plot, permanent species composition plots were designated. Species composition plots were 0.5×2 m long and were divided into 4, 0.5×0.5 m subplots. In each subplot, percent aerial cover was estimated to the nearest 1% for each species that was

rooted in the plot in early June and late August. Maximum cover estimates for each species were averaged across the four quadrats for each plot, which is the data here.

Aboveground productivity:

Each September, above-ground biomass was clipped to ground level within 20 × 50 cm quadrats randomly located in each plot and sorted into graminoids (grasses and sedges), non-graminoid forbs, woody plants, and previous year's dead (in years when there was no burn). Care was taken to not resample areas that were previously clipped and the permanent species composition plots were never clipped. After clipping, biomass was dried at 60 °C for ca. 48 hours and then weighed. Previous year's dead biomass (unburned years) was not included in estimates of annual productivity.

Note: Pretreatment data in 2002. Starting in 2003, 0 or 10 g m⁻² N added and 0, 2.5, 5, or 10 g of P g m⁻² added in a fully factorial design. Experiment is located in watershed 2C, species community composition data and productivity data are collected annually. Additionally, mycorrhizal root colonization data and soil nutrient data has been collected sporadically. If anyone is interested in the mycorrhizal or nutrient data they should contact M. Avolio.

PPS01

Title: Konza Prairie Plant Species List

Purpose: This list was created in order to maintain consistency in the identities of vascular plant taxa through time and across various datasets. The names applied to any particular species often vary over time due to taxonomic revision. Various names may also be applied to a single species by different individuals or groups based on colloquial or idiomatic application of names that are more (or less) up-to-date. Each species is, therefore, given a numeric code that serves as an anchor for its identity. With the identities of its members intact, each dataset can maintain its integrity through time and may be further integrated with other datasets.

Date data commenced: 01/02/1971

Date data terminated: ongoing

Methods:

Originally, this dataset was populated with species that were thought to be the most likely to occur in plots onsite. Later, the names of all species known to occur on KPBS were added. Currently, species are added to the list only after having been identified and located within experimental plots that utilize these codes in their associated datasets. New species are assigned the next available number. Names and attributes are applied based on an acceptable and current taxonomic treatment.

Additional information:

New species are added annually as needed. Names for previously recorded species are updated on an approximately decadal basis.

PRE02

Title: Reproductive effect of Big Bluestem, Indiangrass and Little Bluestem on selected Konza Prairie LTER watershed

Purpose: To estimate seed reproduction, flowering stem mass, height, and population densities of three dominant prairie grasses: Andropogon gerardii (ANGE), Sorghastrum nutans (SONU), and Schizachyrium scoparium (ANSC) in the Konza Prairie LTER watersheds.

Date data commenced: 10/01/1982

Date data terminated: ongoing

Location of Sampling Stations:

Florence and Tully locations of un-grazed watersheds: 001d, R01a, R01b, 002c, 002d, 004a, 004b, 020b, R20a, R20b, 0SpA, 0SpB, 0SuA, 0SuB, 00FA, 00FB, 00WA and 00WB. Sampling is done 2-3 m away from the permanently marked species composition transect. Densities are always measured on the opposite side of the species composition transect from where PAB biomass clipping is done.

Frequency of Sampling:

Once per year at the time of seed maturation (Oct to Nov).

Variable Measured:

1. Flowering stem heights (in centimeters), 1982-present = **PRE021**
2. Weight of inflorescences (g per m²), 1982-1993=**PRE021**
3. Density of flowering stems (No. per m²), 1982-present = **PRE022**
4. Weight of flowering stems (g per m²), 1982-present = **PRE022**

Methods:

Because these measurements involve destructive sampling, no permanently marked plots were set up. All samples are taken 2-3 m parallel to the permanently marked species composition plots at each LTER site.

Individual flowering stem heights (PRE021): 1982 - present

A quasi-random walk is initiated adjacent to the permanent LTER transects during which 25 sampling points per transect (100/LTER treatment) are located at intervals of about 2 m. At each sampling point, the stem height for the nearest (no more than 1m from observer) flowering individual of each of the three species is measured to the nearest cm. Mean flowering stem height is calculated for each species at each site from the 100 values.

Density and weight of flowering stems (PRE022): 1982 - present

Along a transect parallel to the permanent LTER plant species composition transects but on the opposite side from where the PAB biomass collections for the year have occurred, six 0.25m² plots (50cm x 50cm) per transect (x4 transects = 24 per site) are sampled. Each plot is 3 m from the species composition marker and 10 paces from the next plot. Within each of these plots, the number of flowering stems of each species is counted and the stems are clipped at ground level, bagged by species, oven dried at 60°C, and weighed. The density of

flowering stems (No. per m²) and the mean biomass of flowering stem (g per m²) are calculated for each species.

Summary of All Changes:

PRE021: Prior to 1994, at the first 10 points (or first 10 plants sampled), the inflorescence of each individual was clipped and placed in a separate bag. The seed heads were oven dried at 60°C and weighed. From this data (n=40 plants per species), mean seed weight per plant was calculated for each species at each LTER site.

PRE022: Prior to 1992, following drought years (when reproduction by the three species may be very low) flowering stem density was estimated during the fall by counting flowering stems in the 10m² circular plots. Flowering stem height and seed weights were measured on those species flowering adjacent to the transects. Using this technique, sample size was variable for flowering stem height and seed weight measurements. Low sample sizes may necessitate pooling replicate LTER treatments.

Grazed Watersheds (exclosures): Measured 1987 - 1992. Height and density of flowering stems: In each grazed LTER watershed there were eight permanent 5 x 5 m grazing exclosures, four located on Tully soil sites and four located on Florence soil sites. Adjacent to each permanent exclosure, another 5 x 5 temporary exclosure was erected and remained in place only during the year during which stem density and biomass data were collected and only from May 1 until the vegetation reached peak biomass. This provided exclosures in pairs, the permanent exclosure half providing an un-grazed treatment and the temporary exclosure half providing a grazed treatment (grazing is only temporarily prevented to allow re-growth biomass and flowering stem measurements).

Watershed	Site	Exclosure Nos.	Year started
N01A	Florence	1 – 4	1988
N01A	Tully	5 – 8	1988
N01B	Florence	1 - 4	1992
N01B	Tully	5 – 8	1992
N04A	Florence	9 – 12	1988
N04A	Tully	13 – 16	1988
N04D	Florence	9 – 12	1992
N04D	Tully	13 – 16	1992

Within both the grazed half and un-grazed half of the paired exclosures, four 50 x 50 cm quadrats were randomly distributed (excluding the edge within 1 m of the exclosure fence) and the number of flowering stems of each of the three grass species were counted and recorded. In addition, four of the flowering stems of each species were randomly selected and their heights were measured to the nearest cm. The density of flowering stems (No. per m²) and mean flowering stem height were calculated for each species at each LTER site.

Brief History of the PRE021-PRE022 Data Set:

In 1981, a study was initiated on seed production and flowering culm density of Andropogon gerardii (ANGE), Sorghastrum nutans (SONU), and Schizachyrium scoparium (ANSC). This study measured the flower stalk density, height and seed production for each species. The objective of these measurements was not for population/demographic

studies, but rather to provide an additional indicator of patterns of grass production to complement and supplement the long-term ANPP data set.

In 1982, this study underwent slight alterations. The data collected in 1981 was labeled PRE011 while the measurements taken in 1982 and after were designated PRE02.

PRP01

Title: Konza Prairie long-term restoration study of aboveground annual net primary production (ANPP)

Date data commenced: 02/02/1998

Date data terminated: 12/30/2012

Location of Sampling Stations:

Methods:

The experiment is a randomized complete block design with four whole plot heterogeneity treatments replicated within each of four blocks (n=16 whole plots). The whole plot treatments were created using different combinations of soil depth and nutrient manipulations. The control plots contained no depth or nutrient manipulations. The "maximum heterogeneity" plots contained three 2 m x 8 m vertical strips assigned to ambient, enriched and reduced N treatments and four 2 m x 6 m horizontal strips assigned to deep and shallow soil to result in six treatment combinations. The maximum heterogeneity plots are a split-block design. Each plot contained 12 subplots (2 m x 2 m) for sampling. All of the plots had surface soil temporarily removed to a depth of approximately 25 cm and natural limestone slabs were laid in strips assigned to the shallow soil treatment. The soil from all plots was then replaced, leveled, and disked (2-3 cm deep). In February 1998, we incorporated sawdust (49% C; C:N ratio=122) into the strips assigned to the reduced-N treatment. The average C concentration and bulk density in the surface 15 cm following long-term cultivation was 1.5% and 1.2 g cm⁻³, respectively. Sawdust was tilled into the soil at a rate of 5.5 kg dry wt./m² to achieve a C concentration representative of native prairie soil (approx. 3% C). Surface applications of granular sugar were initiated in 2004 at a rate of 200 g sucrose m⁻² (84.22 g C/m²) 3-4 times each growing season. Strips assigned to the enriched-N treatment were fertilized with 5 g N m²/y (applied as ammonium-nitrate) in July of the first growing season and early June of each subsequent year.

Biomass was harvested from 0.1 m² quadrats in each of the 12 subplots within the maximum and control whole-plot treatments. Biomass was clipped at the end of each growing season in 1998, 1999, 2000, 2005, and 2012 corresponding to 1, 2, 3, 8, and 15 years since the agricultural field was sown with native grasses and forbs. Biomass was dried for 1 week at 60°C, sorted into this and previous years' growth, and weighed.

PRP02

Title: Plant diversity, richness, and plant species cover in konza prairie restoration heterogeneity plots, since 1998

Purpose: To investigate how varying soil depths and nutrient levels—both enriched and reduced nitrogen conditions—affect plant and soil processes in prairie ecosystems.

Date data commenced: 02/02/1998

Date data terminated: ongoing

Location of Sampling Stations:

Variable Measured:

Whole plot level diversity, richness and plant species cover; and Subplot level diversity, richness and plant species cover.

Methods:

In 1998, all plots were sown with 42 native prairie species, using a log-normal distribution of dominant grasses and subordinate forbs to resemble never-cultivated tallgrass prairie (Baer et al. 1999, Baer et al. 2003). In 2005, seeds of 15 additional forb species were sown into all plots at a rate of 25 live seeds/m² (Baer et al. 2016). Beginning in 2013, we added 17 additional species (14 forbs, 2 grasses, and 1 sedge) that were never previously recorded in this experiment, but occur at KPBS, to all plots. Seeds were hand-broadcasted in spring each year at a rate of 20 live seeds/m² per species for a total seeding rate of 300 live seeds/m².

The experimental area was fenced in 1998 to prevent deer browsing and has been burned almost annually in the early spring (a common management practice in this region) since 1998, with the exception of 2000 and 2003. Each plot was divided into twelve 2 m x 2 m subplots based on the orthogonally-crossed assignment of treatments in the maximum heterogeneity plots. The percent cover of each species was visually estimated in two permanent 0.5 m × 0.5 m quadrats in each subplot in late spring (late May – early June) and late summer (late August – early September) from 2013 through 2017.

The maximum cover of each species across the two seasonal samplings was used as the cover value for each species in a quadrat. Maximum percent cover of each species was averaged across the two quadrats in each subplot. Plot-level species richness was calculated by summing the total number of species from all subplots within a plot. Plot-level diversity (Shannon's diversity index: H') was calculated from the average cover of each species across all 12 subplots within a plot.

PRW01

Title: Fine root density and turnover based on root window observations

Purpose: To measure root lengths, new growth and decomposition on annually burned and unburned prairie.

Date data commenced: 02/01/1986

Date data terminated: 10/03/1989

Description and Location of Windows:

In February of 1984 the north bank of an abandoned silage pit north of Headquarters (grid C-15) was selected for the root window site. (The old excavation required only a minor amount of digging to put in the windows.) Four windows, approximately 50 cm wide by 50 cm deep, were installed using the following procedure: First, the walls of the old silage pit were cut into so that a clean, 50 cm x 50 cm vertical face of soil was exposed. A triangle was used to cut the wall of soil so that the exposed surface was indented by a 10% angle from top to bottom (Figure 1). Plexiglas was carefully installed so that about 0.5 cm of space remained open between the Plexiglas and the soil. Soil that had been removed from this surface, dried and sieved was then used to back-fill this open space. Six inches (ca 15 cm) of Styrofoam insulation was placed against the windows when not in use, and the Styrofoam was covered with burlap.

In spring of 1984 this site was burned, and two of the four windows were destroyed by fire. The remaining two windows were monitored for the next two years as a non-LTER data set, (Hayes, D.C. and T.R. Seastedt. Root dynamics of tallgrass prairie in wet and dry years. *Canadian Journal of Botany* (1987)).

In spring of 1986 six additional windows were installed, and the site was again burned. Litter was returned to the soil surface about four of the eight windows, and data was collected on root lengths during the 1986-growing season from May 1 to October 1. In November 1989 the two remaining original windows were replaced due to insect damage to wooden frames.

Variable Measured:

Data available from this procedure include the actual root lengths and the estimates of new lengths and decomposed lengths for each quadrat. Data from this study are available through 1989, at which time study was terminated. The original data (the mylar sheets) is stored for each window for each year. The pre-LTER sheets have been archived, but the pre-LTER encoded data is not available.

Methods:

Lengths are obtained by placing a fitted mylar sheet over the window and tracing all roots. Each sheet is divided into a 50 cm wide by 40 cm deep grid, and lengths are recorded for each 10 cm x 10 cm quadrat. Production is calculated during each two-week interval for

each quadrat by measuring the lengths of roots present at time $t+1$ that are not present at time t . Likewise, decomposition is estimated by the roots presence at time t that are not present at time $t+1$. Quality control is obtained by having the investigator trace the window over two consecutive days. Errors created by failing to draw all roots at time t appear as a false production estimate. False disappearance (decomposition) results by failing to draw all roots at time $t+1$. It is highly unlikely that errors will result from drawing roots that are not there, thus, subtracting the estimate of false production from the bi-weekly production estimate and the false decomposition from the disappearance data is suggested to produce realistic data.

Root tracing is best conducted during the cool of the day, before the sun is high enough to cause flare on the Plexiglas. Insects and poison have distracted from the enjoyment of this exercise.

PTN01

Title: Aboveground net primary productivity along transects spanning topographic gradients on an annually burned and unburned watershed at Konza Prairie

Purpose: To assess patterns in above ground biomass production and soil water content across topographic gradients in two watersheds: one annually burned and one unburned.

Date data commenced: 08/15/1989

Date data terminated: 09/26/1997

Location of Sampling Stations:

Cross-watershed transects were established in two watersheds in 1989, one annually burned (001D) and one unburned (020B). Transects were numbered west to east in an annually burned watershed (001D; grid S-25, S-26) and east to west in an unburned watershed (020B; grid N-29), see Fig. 21. Eleven sampling locations were located along each transect on both watersheds, and marked with 4-foot tall conduit markers. These positions were used for aboveground plant biomass sampling and measurements for soil water content. TDR probes were located adjacent to the conduit and used to estimate soil water content at 15 cm depths across the entire transects, and 30 cm depths where soil depth was sufficient (lowland sites).

Frequency of Sampling:

Aboveground biomass was sampled, using standard LTER clipping methods, in late August-September from 1989-1997 (data are missing from 1992). Soil moisture was sampled approximately every two weeks during the growing season of 1993-1996.

Discontinued September 1996.

Variable Measured:

Total aboveground biomass per unit area and associated sub-categories as in PAB01. Soil moisture was measured by Time Domain Reflectometry (TDR) as in future data set SOLXX.

Methods:

Standing crop biomass data was collected in late season at 11 sites along each transect and sorted in to live graminoids, forbs and woody plants, current year's dead, and previous year dead vegetation. All data except previous years' dead are combined to provide an estimate of aboveground NPP. Four 0.1m² quadrats were harvested at each of the 11 sites per watershed near the end of the growing season. Data for individual quadrats are reported for 1989 and 1991-1997. Data from 1990 are reported as mean values for each transect point location (see PTN01 metadata for more information on data formats). In 1993, soil moisture measurements began along each transect at 15 and 30 cm depths (where possible) using permanently installed probes and a portable Time Domain Reflectometry system. Soil moisture measurements were made at approximately two-week intervals from April-October.

PVC01

Title: Plant species composition on selected watershed at Konza Prairie (1981 only)

Purpose: To record differences in plant species composition due to burning and soil effects

Date data commenced: 04/04/1981

Date data terminated: 09/29/1981

Location of Sampling Stations:

20 plots each 10 m² in Tully and Florence soils in 000B, N00D, 001D, N01B, 004B, N04D (1981)

Frequency of Sampling:

In each of the 12 soil-treatment areas one 45 x 36 m quadrant was established that was divided into eighty 4.5 x 4.5 m plots. Twenty of these plots were randomly chosen to be sampled.

Variable Measured: Date, location, soil, species

Methods:

In each plot the area occupied by the canopy (the area enclosed by lines connecting the canopy extremities) is recorded by use of size classes: 0-1, 1-5, 5-25, 25-50, 50-75, 75-95, and 95-100%.

PVC02

Title: Plant Species Composition on selected watershed at Konza Prairie

Purpose: To determine long-term changes in canopy cover, frequency, richness, and diversity in watersheds from different burn treatments in grazed and ungrazed watersheds.

Date data commenced: 06/29/1983

Date data terminated: ongoing

Location of Sampling Stations:

Plant composition is determined on upland topographic locations (Florence soils), lowland topographic locations (Tully soils), and slope locations. Maps of sampling locations are available as following PVC map.

Sampling History:

Collection of plant composition data began in 1983 in watersheds 1c, 1d, 4b, 20b, N1b, N4d, and N20b. Since then, numerous other watersheds have been added and an annual plant census is currently conducted in: 1d, 2c, 2d, 4a, 4b, 20b, N1a, N1b, N4a, N4d, N20a, N20b, Fa, Fb, Wa, Wb, Spa, Spb, Sua, Sub, R1a, R1b, R20a, R20b. Sampling in the eight seasonally burned watersheds began in 1994. Four reversal watersheds were established in 2001 in which 1a became R20a, 20a became R1a, 1c became R20b, and 20d became R20b. Only Florence soils (f) are sampled in 2c and 2d, whereas only Tully soils (t) are sampled in R1a and R20a. Sampling on slope sites (s) in 1d, 1c, 4a, 4b, 20b, 20d, N4a, N4d, N20a, and N20b were conducted from 1991-2001, but are currently sampled only in the bison-grazed watersheds.

Frequency of Sampling:

Initially, plots were surveyed 3 times each year. Beginning in 1991, however, sampling frequency was changed to twice a year (late-May to Mid-June for the spring census, and August to early-September for the summer census). Generally, cool-season species are sampled in the spring census whereas warm-season species are sampled in the summer census when they are more developed.

Variable Measured:

Canopy cover of all vascular plant species in each plot are estimated.

Methods:

In each watershed, four 50-m long transects (A, B, C, and D) were established on each topographic position. In each transect, five evenly spaced, permanently marked plots are located (n = 20 plots for each topographic position in a watershed). A surveyor's pin with a 1.78 m long chain is placed in the conduit marking each plot. Canopy cover of all vascular plant species in a 10-m² circular area within each conduit are estimated using a modified Daubenmire cover scale (Bailey and Poulton, 1968. Ecology 49:1-13). Cover categories are:

<u>Class</u>	<u>Cover</u>	<u>Mid-point</u>
1	<1%	0.5%
2	1-5%	3.0%
3	5-25%	15.0%
4	25-50%	37.5%
5	50-75%	62.5%
6	75-95%	85.0%
7	95-100%	97.5%

Form of Data Output:

Raw data contains the cover class value for each species detected in the plot. For species that are sampled on both census dates, the highest cover class of each plot is used for analyses. Percentage cover for each species is computed by averaging the mid-points of the cover classes for the 20 plots. The presence or absence of a species in the 20 plots can be used to estimate frequency of occurrence.

Summary of All Changes:

Transect E only occurred on watershed N20B florence from 1983 to 1987. This transect was established before bison reintroduction and was abandoned after fence construction left it outside of the treatment area. The current N20B florence transect D was established in 1986 to replace the old transect E. Many watersheds have experienced name changes over the duration of data collection, so one physical sampling location may have different watershed designations in the dataset.

Notes: For watershed R20B, no data were collected in the transects A and B in the summer of 2011 due to wildfire. Summer sampling for watershed R1A and R20A did not occur in 2014 due to personnel changes. Plots in the bison area were established prior to bison reintroduction. Grazing began in the 1988 growing season for Phase I watersheds (N1A, N2A, N4A, N4C, N20A) and 1992 for Phase II watersheds (N1B, N2B, N4B, N4D, N20B).

For list of watershed names, list of species codes, and PVC experiment map, see <http://lter.konza.ksu.edu/content/pvc02-plant-species-composition-selected-watersheds-konza-prairie>.

PWV01

Title: Cover of woody vegetation at Konza Prairie

Purpose: Relate effects of soil, grazing intensity and burning treatments on the establishment and subsequent growth of woody plants in prairie communities and how these factors affect the prairie-forest boundary.

Date data set commenced: 06/01/1981

Date data set terminated: 06/01/1986

Watersheds Sampled:

1981: 020B, 020C, 020D, 001A, 001D, 004B, 004F, 004G, 004H, 010D, 033A, 033D, 099C

1986: 020B, 020C, 020D, 001A, 002D, 001D, 004B, 004F, 004G, 004H, 010D, 033A, 033D, 099C, N20B, N01B, N04A, N04D

1991: 001D, 002D, 004B, 020B, N01B, N04D, N20B

1996: 001D, 002D, 004B, 020B, 001A, 020A, N01B, N04D, N20B, 020C, 020D

Frequency of Sampling:

Beginning in 1981 and every five years thereafter.

Variable Measured:

Location of each individual tree, shrub and patch of scrubs according to species and size.

Methods:

Each area is walked in parallel lines approximately 15-20 m apart. The locations of woody vegetation are marked on a mylar overlay on a large-scale aerial photograph of the area being surveyed with a unique symbol for each species and a number for size. A real effort is made to detect young individuals in order to estimate when growth started and ascertain mortality in the early years. Species are coded by symbols and color.

For trees, size is the height to the nearest meter above 2 m. For shrubs, the approximate diameter and shape of the patch is drawn on the overlay.

Form of Data Output:

A GIS file is prepared for each watershed and the raw ASCII X, Y file coordinates are available for 1981 and 1986.

PWV02

Title: Importance values of gallery forest vegetation at Konza Prairie, 1983

Purpose: Collect base-line woody vegetation data from Konza Prairie gallery forests

Date data commenced: 05/23/1983

Date data terminated: 08/17/1983

Location of Sampling Stations:

Kings Creek, North and South branches of Kings Creek, Shane Creek (including North and South branches), and White Pasture stands.

Frequency of Sampling:

18 stands (one per site) were selected as homogeneous units of gallery forest vegetation large enough to contain 20 sample points (at 30 paces apart).

Variable Measured: Date, location, species, variety, diameter, age

Methods:

Point-quarter method, 20 points surveyed per stand. Points laid out systematically (every 30 paces) along a transect through the midpoint between gallery forest edge and stream. Ages of 2 selected trees per point were determined by tree coring.

Other Data

ABG01

Title: Aboveground and belowground invertebrate biodiversity responses to patch-burn and annual burn grazing management at Konza Prairie (2021-2023)

Purpose: The study aimed to evaluate how patch-burn grazing (PBG) versus annual burning and grazing (ABG) influences the diversity, composition, functional structure, and chewing herbivory of aboveground invertebrate communities.

Date data commenced: 01/04/2021

Date data terminated: 12/29/2023

Location of Sampling Stations: Sampling was conducted within four long-term grazing units at Konza Prairie Biological Station (KPBS) in Manhattan, Kansas. Two ABG units (93 ha and 76 ha; burned annually). Two PBG units (455 ha and 219 ha; burned in tri-annual rotation). Each PBG unit was divided into three watersheds, each with a different year since burning (0, 1, or 2 years). Watersheds followed KPBS designations but are summarized in the study as ABG_0, PBG_0, PBG_1, and PBG_2. Each watershed included eight 1 m² plots (N = 64 total plots). The names of each watershed are included in the data file.

Frequency of Sampling: Aboveground invertebrates were sampled once per year in July, from 2021 to 2023, between 10:00 AM and 2:00 PM on days with clear skies and low wind. Herbivory was sampled once per plot in June of 2025.

Variable Measured: Invertebrate Abundance, percent herbivory (Insect chewing damage to plants).

Field Methods:

ABG011, ABG012: Each of the four grazing units contained transects with fixed 1 m² plots. Invertebrates were sampled using a reverse leaf blower fitted with a mesh collection bag for 60 seconds per plot. This method is effective for collecting small, foliage-dwelling insects (e.g., aphids, thrips, leafhoppers) and was chosen for its effectiveness in capturing mobile arthropods. Samples were immediately stored on ice and then frozen at -20 °C until processing.

ABG013: Insect herbivory was estimated in the field during July sampling periods (2021–2023) at Konza Prairie Biological Station. Surveys were conducted on eight dominant plant species, selected based on the Dominance Candidate Index (Avolio et al. 2019), which included four graminoids (*Andropogon gerardii*, *Carex inops*, *Dichanthelium oligosanthes*, *Sorghastrum nutans*) and four forbs (*Ambrosia psilostachya*, *Solidago missouriensis*, *Amorpha canescens*, *Ruellia humilis*). Within each 50-m transect, we visually divided the transect into approximate thirds. In each third, the nearest individual of each target species to a centrally placed flag was selected (3 individuals per species per transect). Herbivory was assessed by

visually estimating chewing damage on the second highest fully developed leaf of each plant. Estimates were recorded as a percentage of leaf area damaged, to the nearest whole number

Laboratory Methods:

Samples were thawed and sorted to remove plant debris. Invertebrates were identified to the family level using dichotomous keys based on morphological features. Damaged specimens were identified to order when necessary.

Form of data output: Count/abundance data

Quality Assurance: All field and lab protocols were standardized and followed consistent procedures across all years.

Protocol title, or URL online protocol: Vacuum Arthropod Sampling in Grasslands
(https://nutnet.org/sites/default/files/Stewart_&_Wright_1995.pdf(link is external))

Insect herbivory was assessed in July 2021–2023 at Konza Prairie Biological Station by visually estimating chewing damage on eight dominant plant species, selected using the Dominance Candidate Index (Avolio et al. 2019). Each 50-m transect was divided into three sections, and in each, the nearest individual of each species to a central flag was selected, totaling three individuals per species per transect. For each plant, chewing damage was estimated as the percent leaf area removed on the second highest fully developed leaf, recorded to the nearest whole percent. Only chewing damage (e.g., missing margins or holes) was considered; mining or discoloration was excluded.

AOP01

Title: Correspondence between plant traits and NEON Airborne Observatory Platform (AOP) data at Konza Prairie (2017)

Purpose: Understanding spatial and temporal variation in plant traits is needed to accurately predict how communities and ecosystems will respond to global change. The National Observatory Ecological Network (NEON) Airborne Observation Platform (AOP) provides hyperspectral images and associated data products at numerous field sites at 1 m spatial resolution, allowing high-resolution trait mapping. However, the reliability of these data depend on establishing rigorous links with in-situ field measurements. We tested the accuracy of NEON's readily available AOP derived data products – Leaf Area Index, Total biomass, Ecosystem structure (Canopy height model; CHM), and Canopy Nitrogen by comparing them to spatially extensive field measurements from a mesic tallgrass prairie. Correlations with AOP data products exhibited generally weak or no relationships with corresponding field measurements. The weakest relationships were between AOP Canopy Nitrogen and ground-based measures of Nitrogen, as well as the CHM and ground-based canopy height measurements. We also examined how well the full reflectance spectra (380-2500 nm), as opposed to derived products, could predict vegetation traits using partial least-squares regression models. Only one of the eight traits examined, Nitrogen, had an R² of more than 0.25. For all vegetation traits, R² ranged from 0.08-0.29 and the root mean square error of prediction ranged from 14-64%. Our results suggest that currently available AOP derived data products are unreliable, at least at this grassland site, and should not be used without extensive ground-based validation. Relationships using the full reflectance spectra may be more promising, although additional assessment of varying spatial scales of field and AOP data, as well as corrections and data pre-processing to improve data quality, are recommended. Finally, grassland sites may be especially challenging for airborne spectroscopy because of their high species diversity within a small area, mixed functional types of plant communities, and heterogenous mosaics of disturbance and resource availability. Remote sensing observations are one of the most promising approaches to understanding ecological patterns across space and time, yet the opportunity to engage a diverse community of NEON data users will depend on establishing empirical relationships with field measurements across a diversity of sites.

Date data commenced: 06/08/2017

Date data terminated: 12/31/2017

Location of Sampling Stations: Konza Prairie, KS

Methods:

1. NEON AOP data are downloaded, clipped to Konza boundaries.
2. AOP data are extracted for pixel locations corresponding to 200 field plots in Konza.
3. AOP data and field data are merged.
4. Correlations are examined between AOP and field data.
5. Partial least squares regression models are run using AOP spectra to predict field data.

BGPVC

Title: Plant species composition in the Belowground Plot Experiment at Konza Prairie

Purpose: To determine the canopy coverage of all plant species and total species coverage, richness, and diversity.

Date data commenced: 1989

Date data terminated: ongoing

Location of Sampling Stations: LTER belowground study plots.

Sampling History:

In 1989, sampling was done once in early July after mowing using one 10 m² plot placed randomly in the approximate center of each plot. In 1994, plant composition sampling was done in early June in the unmowed plots; sampling in the mowed plots occurred in August. In 1999, two permanent conduits were placed in each plot, and sampling was conducted in June, before mowing, and again in August using 5 m² plot sizes. In 2005 and afterward, sampling was reduced to one time in late July. Sampling occurred once every five years until 2015. Plots have been sampled annually since 2016.

Frequency of Sampling: See above.

Variable Measured: Estimated canopy coverage class for each species.

Methods:

To assess plant species composition all plant species in a 5 m² circular plot are recorded. A surveyor's pin is placed in the conduit marking the center of the plot. Attached to the pin is a 1.26 m long chain with a ring at the free end. The observer holds the ring on a finger, pulls the chain taut, and walks in a circle around the circumference of the plot defined by the chain radius. For each plot, canopy coverage of all species are estimated using a modified Daubenmire cover scale (Bailey and Poulton, 1968, Ecology 49:1-13). Cover categories are:

<u>Class</u>	<u>Canopy cover</u>	<u>Mid-point</u>
1	< 1%	0.5%
2	1 - 5%	3.0%
3	5 - 25%	15.0%
4	25 - 50%	37.5%
5	50 - 75%	62.5%
6	75 - 95%	85.0%
7	95 - 100%	97.5%

Form of Data Output:

Canopy coverage is computed for each plot by averaging the midpoints of the cover class ratings for each species for the 2 plots at each sampling period.

BMS01

Title: Mycorrhizae spore density and composition in the Belowground Plot Experiment at Konza Prairie

Purpose: To determine mycorrhizal fungus species composition and number in the Konza Prairie LTER Belowground study plots. Percentage mycorrhizal colonization and colonization intensity of sampled plant roots will also be determined.

Date data commenced: 06/11/1987

Date data terminated: 12/31/1987

Location of Sampling Stations:

LTER belowground study plots – sampled every 5 years.

Variable Measured:

1. Mycorrhizal species composition per gram (dry wt) soil
2. Spore density of each mycorrhizal species per gram (dry wt) soil
3. Percent mycorrhizal root colonization of sampled plant roots

Methods:

Ten 15 x 1.8 cm cores are removed from each LTER sample plot. The cores are randomly taken from throughout the plots with a 25 x 1.8 cm soil probe. Percent moisture is calculated and 100-500 g (dry wt) soil are examined from each sampling site. Samples are blended in water, wet sieved through a 38 µm sieve, decanted and subjected to 20, 40 and 60% sucrose density centrifugation (Daniels and Skipper, 1982) to separate spores from organic matter. Spores thus collected are then examined microscopically to determine the number of spores and identity of each species present. Roots from each sample were washed free of soil, stained with trypan blue (Phillips and Hayman, 1970), and examined microscopically to determine percentage root colonization (Kormanik and McGraw, 1980).

Daniels, B. A., and H. D. Skipper (1982). Methods for the recovery and quantitative estimation of propagules from soil. IN: *Methods and Principles of Mycorrhizal Research* (N. C. Schenck, Ed.), pp. 29-37. American Phytopathological Society, St. Paul, Minn.

Kormanik, P. P., and A. C. McGraw (1982). Quantification of vesicular-arbuscular mycorrhizae in plant roots. IN: *Methods and Principles of Mycorrhizal Research* (N. C. Schenck, Ed.), pp. 37-47. The American Phytopathological Society, St. Paul, Minn.

Phillips, J. M. and D. S. Hayman (1970). Improved procedures for cleaning roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. *Transactions of the Mycological Society* 55:158-160.

BNS01

Title: Nematodes density and composition in the Belowground Plot Experiment at Konza Prairie

Purpose: To examine the effects of burning, mowing, and nitrogen (N) and phosphorus (P) fertilization on the trophic structure of the tallgrass prairie nematode community.

Date data commenced: 1987

Date data terminated: ongoing

Methods:

Composite soil samples consisting of four 5 cm diameter \times 20 cm deep cores were collected in a systematic pattern from each plot in October of 1987, 1989, and 1994, following peak plant biomass production. To differentiate effects due to treatment per se from those due to changes in plant species composition which resulted from treatment, a second set of soil samples, with sampling restricted to the rhizosphere of *A. gerardii*, was collected in October 1989. Nematodes were extracted from 100 cm³ subsamples using a modified Christie-Perry technique (Christie and Perry, 1951). Nematode counts were adjusted for extraction efficiency as determined by repeated extractions of selected samples. Extracted nematodes were identified to genus and assigned to one of the following trophic groups based on information summarized by Yeates et al. (1993b): (1) herbivore (root-feeding); (2) fungivore (hyphal-feeding); (3) microbivore (bacterial- and unicellular eucaryote-feeding); (4) predator (invertebrate-feeding); (5) omnivore (primarily invertebrate-feeding). In view of conflicting observations on the feeding habits of the Tylenchidae (root vs. fungal feeding; Yeates et al., 1993b), which represents a large component of the nematode community in tallgrass prairie, this family was analyzed separately from obligate herbivore taxa (sensu Yeates et al., 1993a). Conversely, since the major omnivorous nematodes in tallgrass prairie (represented by genera of the Dorylaimida) are primarily predaceous, these two trophic groups were combined for analysis (sensu Sohlenius et al., 1988). The dominant tallgrass prairie nematode taxa associated with each trophic group have been reported in an earlier publication (Seastedt et al., 1987). A list of nematode species native to tallgrass prairie can be found in Orr (1965).

BNS02

Title: Belowground Plot Experiment nematode at Konza Prairie, 1987-2017

Purpose: This project addresses the long-term effects of fire (annual burning or fire suppression), mowing, and nitrogen (N) and phosphorus (P) fertilization on the structure and composition of a tallgrass prairie nematode community during 30 years of experimental treatments.

Date data commenced: 05/01/1987

Date data terminated: 6/30/2017

Methods:

Composite soil samples consisting of either four 5-cm diameter cores (1987, 1989, 1994) or four to twenty 2.5-cm diameter cores (post 1994) were collected to a depth of 20 cm in a systematic pattern from each plot in June or October. Initial samples were collected in October 1987 and 1989, with subsequent sampling events occurring at approximately 5-year intervals. The final sampling occurred in June 2017.

Nematodes were initially extracted from 100 cm³ subsamples using a modified Christie-Perry technique (Christie and Perry, 1951) consisting of sieving followed by tissue extraction. Due to poor recovery of criconematid nematodes, the centrifugal flotation procedure (Jenkins, 1964) was used after 1994. Extracted nematodes were identified to genus and assigned a feeding habit based on Yeates, et al. (1993). A complete list of nematode genera and species present in the BGPE can be found in Darby, et al. (2013). Detailed methods and results from nematode-focused sampling in the BGPE are reported in Todd (1996), Jones, et al. (2006), and Darby, et al. (2013).

CEE01

Title: The Climate Extremes Experiment (CEE): Assessing ecosystem resistance and resilience to repeated climate extremes at Konza Prairie

Purpose: To assess response of recovery of tallgrass prairie plant community composition and ecosystem function to repeated extreme drought events.

Date data commenced: 2010

Date data terminated: 2013

Location of Sampling Stations: HQA

Frequency of Sampling: Annually (ANPP), twice-annually (plant species composition, plant stem densities), bi-weekly to monthly (soil CO₂ flux)

Methods:

Four large rainfall manipulation shelters (each 6 x 26 m in size) were established in 2010. Within each shelter are 10 2 x 2 m plots arranged in two offset rows of 5 plots each. Each 2 x 2 m plot is divided into four 1 x 1 m subplots. One subplot is designated for plant species composition measurements. The remaining three are designated for soil CO₂ and ANPP measurements. Plant community composition is measured in early (late-May or early June) and late growing season (mid to late August) by estimated the aerial cover to nearest 1% (<25%), 5% (26-50%), or 10% (>50%) in a permanent 1 x 1 m plot. Plant stem densities are measured at the same time as plant species composition early in the growing season. All stems are counted within a permanently marked 20 x 50 cm quadrat located within the 1 x 1 m species composition plot. Stems are separated into the following categories: *Andropogon gerardii*, *Sorghastrum nutans*, *Solidago canadensis*, other grass, other forb, and woody. Productivity is measured by clipping all aboveground biomass within two 20 x 50 cm quadrats. The biomass is separated in the field to the following categories: *Andropogon gerardii*, *Sorghastrum nutans*, *Solidago canadensis*, other grass, other forb, and woody. Soil CO₂ collars are installed in two subplots at the beginning of the growing season and measurements are made on a bi-weekly to monthly basis.

Quality Assurance: Entered data is checked twice.

CME01

Title: The Consumer Size Manipulation Experiment (ConSME) at Konza Prairie

Purpose: Invertebrate (Coupe & Cahill 2003, Schadler *et al.* 2008, Blue *et al.* 2011, Allan & Crawley 2011) and non-ungulate vertebrate herbivores (Edwards & Crawley 1999, Howe *et al.* 2002, Bakker *et al.* 2006) can have strong effects in grasslands, with insect herbivore outbreaks capable of causing state-dependent shifts in plant communities (Karlsen *et al.* 2013). However, feedbacks from small herbivores on plant community composition and ANPP are poorly understood. We will examine the relative impacts of different herbivore groups to assess the importance of these groups in top-down control of grassland structure and function. In the ongoing Vertebrate-Invertebrate Plot experiment in 2C at Konza, we found that insects increase forb diversity, but depress forb biomass and responses to nutrient addition (La Pierre 2016). However, the responses and relative strengths of different herbivore groups at KNZ remain largely uncharacterized with respect to fire-grazing interactions, topography or climate. Nutrient availability alters plant quality and species composition, and can affect invertebrate herbivore abundances, trophic structure, and behavior (Joern & Mole 2005, Cleland *et al.* 2004, Hartley & Jones 2004, Jonas & Joern 2008, Blue *et al.* 2011). Manipulating plant stoichiometry increased grasshopper herbivory on plots fertilized with N, but not P (Loaiza *et al.* 2011), consistent with predictions based on grasshopper feeding trials (Jonas & Joern 2008, 2013, Joern *et al.* 2012). Here, we aim to build upon this previous work to assess the effects of invertebrate and vertebrate herbivores and their interactions with fire frequency on grassland plant community composition and aboveground biomass.

Date data commenced: 01/01/2019

Date data terminated: ongoing

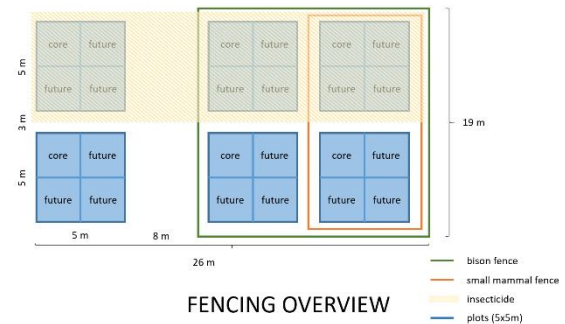
Methods:

We are examining the effects of herbivores of varying size classes on grassland plant community composition and aboveground biomass in the lowlands of Konza Prairie watersheds N1B and N4D. To address the interactive effects of top-down control over grassland communities and fire, the experiment was set up in two adjacent watersheds, one burned annually (N1B) and one burned once every four years (N4D). Plots are 5 x 5 m in area and treatment replicates (N=9) are arrayed in nine blocks within each watershed. Plots within each block are separated by 3 m aisles (with the exception of control plots, which are located 8 m from the fenced plots to prevent trampling effects of bison as they rub on the cattle panels and t-posts), and blocks are located haphazardly throughout the watershed. All plots are permanently marked with conduit.

Three herbivore removal treatments are applied within the conSME experiment: (1) bison removal; (2) small mammal removal; and (3) insect removal. The small mammal removal treatment is nested within the bison removal treatment, while the insect removal treatment is crossed with all other treatments. Thus, a total of six treatments are applied within each block: (1) control (all herbivores have access), (2) insect removal, (3) bison removal, (4) bison and insect removal, (5) bison and small mammal removal, (6) bison, small mammal, and insect removal.

The bison removal treatment consists of cattle panels surrounding the plots to prevent access by bison, but allowing access by small mammals and insects.

The small mammal removal treatment involves surrounding the entire plot with a ¼” hardware cloth fence. This fence consists of a 1 m high fine mesh, which is buried to a depth of 5” to discourage burrowing under fences. An 8” strip of metal flashing is affixed to the top of the hardware cloth to prevent herbivores from climbing over the fence and into the plots. The small mammal removal treatment excludes all vertebrate herbivores from the plots, but does not prevent access by invertebrate herbivores.



The insect removal treatment is applied by spraying Spectrum triazicide insecticide once every two weeks throughout the growing season on a windless day. In a similar experiment (**VIR01**), this treatment removes roughly 70% of insects from the plots. An equal quantity of water is added to the insect control plots.

To determine the effects of various herbivore removals on grassland productivity and diversity, plant species composition and end-of-season above-ground biomass are sampled yearly. Pre-treatment data was collected in 2018, and treatments were initiated in 2019. Plant species composition is measured in a permanent 1m² subunit within each of the experimental plots twice per growing season, once in spring (mid-May to early-June) to determine the abundance of early season forbs and C3 grasses, and once in fall (August) to determine the abundance of late season forbs and C4 grasses. Percent cover is determined for each species to the nearest 1% using a modified Daubenmire method. Two permanent 1m² subunits within each experimental plot are dedicated to destructive biomass sampling. The aboveground standing crop is sampled once per growing season, at peak biomass (late-August to early-September). One 0.1m² strip is clipped in each of the two destructive sampling subunit in each plot and the location of strips is moved each year to prevent resampling. Biomass is separated by functional group (graminoid, forb, woody), dried at 60 °C, and weighed.

DEM01

Title: Demographic studies of four forb species at Konza Prairie

Purpose: To quantify across species variance in bison and climate responses for a representative suite of forb species at Konza Prairie.

Date data commenced: 06/01/2021

Date data terminated: 11/1/2022

Methods:

We exhaustively searched each transect for all individuals of one of the four species, marking plants and measuring species-specific size and fruit measurements that correlate with all dried biomass and with fruit number. We then returned annually to remeasure sizes and fruits, score survival, and estimate reproduction. Transects were of variable length and housed in annual, 2- and 4- year burn watersheds, in both bison-grazed and ungrazed watersheds.

Starting in 2021, to quantify recruitment, we exhaustively searched for unmarked plants in predefined subsets of the transect if any plants in that subset flowered or fruited during that year's survey or the year prior's survey.

DPP01

Title: Drought experiment nested within the phosphorus plots experiment at Konza Prairie

Purpose: To explore how nutrient-altered tallgrass prairie responds to drought. Seven years of nutrient treatments (control, nitrogen (N), phosphorus (P), and N+P) resulted in significantly different plant communities. Within this experimental context we imposed a three-year drought followed by three years of recovery from drought. We hypothesized (1) the plant functional types would have different responses to drought; (2) the different community types would vary in their resistance to drought; and (3) the control and P treated plots, where N is limited, will have a greater increase in standing biomass production in the previously droughted plots compared to the non-droughted plots.

Date data commenced: 05/01/2010

Date data terminated: 10/31/2015

Methods:

This experiment took place within the Phosphorus Plots experiment in watershed 2C. In 2010 we built fully covered rainout roofs to exclude the majority of rainfall. Roofs were placed in the control, 10 g N, 10 g P, and 10 g N+P treatment plots. Shelters were 2.3 m × 2.3 m, which effectively droughted a 1 m² area in the center of the plot. The shelters went up in April and were taken off in October for each year of the three-year imposed drought, removing rain during that period. We then tracked recovery for three years (2013-2015).

Species composition: Every year (2010-2015) community composition was recorded by estimating the cover of each species to the nearest 1% in late May or early June and in August. Between these two time points the maximum cover of each species is used in subsequent analyses. Species cover data was collected in a 1 m² plot in the center of the shelter, where there was less blow-in, and was divided into four 0.25 m² quadrats. Data from the four quadrats were averaged.

Standing plant biomass: In the years that the site was burned, 2011, 2013, 2015, we used a disc pasture meter, a weighted plate (50 cm diameter) that is dropped onto a plot, and its height is a proxy for standing biomass. In burn years, all aboveground biomass was removed by the fire, and standing biomass is a proxy of how much plants grew over the growing season, or biomass production. We measured standing biomass in each of the subplots within the species composition plot taking four measurements in the four quadrants. The disc is calibrated to Konza uplands (where the experiment took place) and equations were used to convert the height of the disc to standing biomass.

EJR01

Title: Foraging decisions underlying restricted space-use: effects of fire and forage maturation on large herbivore nutrient uptake on Konza Prairie

Purpose: To quantify foraging site selection of Plains bison in order to determine if bison in a fire-prone grassland selected sites of low-to-intermediate forage biomass as posited by Fryxell's (1991) forage maturation hypothesis. Additionally, to understand how foraging patterns shifted when grass regrowth was not possible, we quantified the annual diet of four GPS-collared bison via stable isotope analysis of tail hair plucked during roundup.

Date data commenced: 04/01/2012

Date data terminated: 12/31/2013

Methods:

Recent models suggest that herbivores optimize nutrient intake by selecting patches of low to intermediate vegetation biomass. We assessed the application of this hypothesis to plains bison (*Bison bison*) in an experimental grassland managed with fire by estimating daily rates of nutrient intake in relation to grass biomass and by measuring patch selection in experimental watersheds in which grass biomass was manipulated by prescribed burning. Digestible crude protein content of grass declined linearly with increasing biomass, and the mean digestible protein content relative to grass biomass was greater in burned watersheds than watersheds not burned that spring (intercept; $F_{1,251} = 50.57$, $P < 0.0001$). Linking these values to published functional response parameters, ad libitum protein intake, and protein expenditure parameters, Fryxell's (Am. Nat., 1991, 138, 478) model predicted that the daily rate of protein intake should be highest when bison feed in grasslands with 400–600 kg/ha. In burned grassland sites, where bison spend most of their time, availability of grass biomass ranged between 40 and 3650 kg/ha, bison selected foraging areas of roughly 690 kg/ha, close to the value for protein intake maximization predicted by the model. The seasonal net protein intake predicted for large grazers in this study suggest feeding in burned grassland can be more beneficial for nutrient uptake relative to unburned grassland as long as grass regrowth is possible. Foraging site selection for grass patches of low to intermediate biomass help explain patterns of uniform space use reported previously for large grazers in fire-prone systems.

Foraging site vegetation data: Data set contains estimates of vegetation characteristics at bison foraging sites and paired random non-grazed sites nearby and live graminoid foliar crude protein and adjusted crude protein content at these paired sites for watersheds where bison grazing occurred in 2012-2013.

Bison tail hair stable isotope data: Data set contains $\delta^{13}C$ of yearly composite hair profiles in relation to hair follicle length (cm) for four matriarchal female bison. Values represent averages of $\delta^{13}C$ every 5 mm over a 4-year period (2010–2013) per individual. Hair follicle length represents the distance from the base of the follicle (collection in late October each year) to older portions of the hair closest to the hair tip.

This was Graduate Student Research, a part of research related to KNZ LTER project. For additional metadata and method information, please contact knzltr@ksu.edu or see Raynor et al. 2016 paper.

ESM01

Title: Fire and grazing modulate the structure and resistance of plant-floral visitor networks in tallgrass prairie

Purpose: Determine number of blooming inflorescences of insects-pollinated plant species on 12 Konza watersheds; determine flower-visitor and insect-pollinated plant associations and community interaction network structure; and determine community composition and abundance of flowering-visiting insects on Konza watersheds.

Location of Sampling Stations:

ESM011: 1D, K1B, 4B, K4A, 20B, 20C, N1A, N1B, N4A, N4B, N20A, N20B

ESM012: 1D, K1B, 4B, K4A, 20B, 20C, N1A, N1B, N4A, N4B, N20A, N20B

ESM013: 1D, K1B, 4B, K4A, 20B, 20C, N1A, N1B, N4A, N4B, N20A, N20B

Frequency of Sampling: Twice, once in June and once in July 2014.

Date data commenced: 05/29/2014

Date data terminated: 07/13/2014

Variable Measured:

ESM011: Number of blooming inflorescences of each plant species within two 5 x 50m plots.

ESM012: Abundance of flower-visiting insect morphospecies on inflorescences of flowering-plant species.

ESM013: Abundance insects belonging to the orders of Coleoptera, Diptera, Lepidoptera, and Hymenoptera.

Methods:

ESM011: Within each watershed, one upland and one lowland location was selected haphazardly. Each location, counts of individual inflorescences for each flowering plant species were recorded within a 5 m x 50 m area plot.

ESM012: Within each watershed, one upland and one lowland location was selected haphazardly. At each location, floral visiting insects were collected directly on the inflorescences of flowering plants using sweep nets, by hand, and by observation for large and easily identified insects for 1 person-hour within a 1 ha area by random (haphazard) walk. Insects were collected only if they belonged to one of four orders: Coleoptera, Diptera, Hymenoptera, and Lepidoptera. Insects were separated by the species of flowering plant on which they were collected.

ESM013: Within each watershed, one upland and one lowland location was selected haphazardly. Insects were collected using transects consisting of 12, 70 cm tall, evaluated 9 oz. pan traps (two each of six inflorescent colors; purple, blue, yellow, orange, pink, and white) each spaced 5 meters apart, filled with soapy water, and left out for 3 days at each of the 24 sites during each sampling period. Only insects from the four major pollinator orders of Coleoptera, Diptera, Hymenoptera, and Lepidoptera were included. Collected insects

were washed, stored in 70% alcohol, sorted to morphospecies, and identified to lowest possible taxonomic level.

FWE01

Title: Effects of Browsing and Fire on Woody Encroachment at Konza Prairie

Purpose: To investigate physiological, population and community effects of continuous browsing and fire on *Cornus drummondii*, a resprouting woody species. Through monitoring the shrub's physiology, population and the surrounding plant community composition within these treatments we hope to understand how to best prescribe restoration methods for restoring the tallgrass prairie.

Date data commenced: 05/04/2015

Date data terminated: 10/30/2017

Location of Sampling Stations: Watersheds 4B and 20C

Experimental Methods:

This experiment is located in watersheds 4B and 20C at KPBS. Both watersheds were chosen for their burn frequencies and abundant *Cornus drummondii*. Starting in May 2015, 20 discrete shrub islands were chosen in the lowlands that spanned the length of each watershed. In each watershed, 10 shrub islands were randomly assigned the browsing treatment and the remaining shrub islands act as an unmanipulated control to the browsing treatment. Our browsing treatment is a simulated browsing treatment, where 50% of new aboveground meristematic growth is removed using clippers or hands. Browsing occurs once a month during the growing season (May – September), all biomass removed is moved away from the shrub islands. In watershed 4B a prescribed fire occurred in April 2017.

Data Collection Methods:

Species Composition: This protocol is the same that is used in the PVC02 long-term data set but adapted for our study. In the center of each selected shrub island in watersheds 4B and 20C a surveyor's pin with a 1.78 m long chain is used to get canopy cover of all vascular plants within a 10 m² circular area. Canopy cover is estimated using a modified Daubenmire cover scale (Bailey and Poulton, 1968. Ecology 49:1 – 13), the cover categories are the same as described in PVC02.

Shrub Area: The area was calculated by taking two diameter measurements perpendicular to each other at the center of the shrub islands and then put into an ellipsoidal area equation.

Stem/Ramet Density: Every stem/ramet was counted within the shrub island area before the browsing treatment started and then at the end of the growing season in October. Additionally, stems/ramets were counted a month after the prescribed fire occurred in 4B.

Gas Exchange: During the growing season (May – September) gas exchange measurements were taken once a month around solar noon at each shrub island using a LICOR-6400. Within each shrub island 2 measurements were recorded, the first at the edge of the shrub island and the second at the center of the shrub island. All measurements were taken on new fully expanded leaves.

Leaf Area Index (LAI): During the growing season (May – September) LAI measurements were taken once a month around solar noon at each shrub island using a LICOR-2000. Within each shrub island 2 measurements were recorded, the first at the edge of the shrub island and the second at the center of the shrub island. Additionally, 10 measurements in each watershed were taken in the space between shrub islands as a grassland control for LAI.

¹³C Leaf Stable Isotope: Once a month during the growing season several new fully expanded leaves were clipped from each shrub island in each watershed. These leaves were then dried for 48 hours at 60°C and then powdered using a Wig-L-Bug® grinder. Once ground the leaf material was processed using an elemental analyzer in sequence with an isotope-ratio mass-spectrometer. See Nippert et al. 2013 (<https://doi.org/10.1371/journal.pone.0081630>(link is external)) for an identical protocol.

Diurnal Leaf Temperature: Leaf temperatures were taken every 6 hours during a 24-hour period (6AM, 12PM, 6PM, 12AM) in all of the shrub islands. These measurements were made at least once per month during the growing season (May – September) using an infrared radiometer (Apogee MI-220). Measurements were taken at 3 locations in each shrub island: southern side, center and northern side. At each location 2 measurements were made if possible, first in the upper canopy and the second in the understory. All measurements were made on fully expanded leaves.

Diurnal Soil Moisture: Soil moisture is taken every 6 hours during a 24-hour period (6AM, 12PM, 6PM, 12AM) in all of the shrub islands and at 10 locations between each shrub island in each watershed. Measurements were taken at 3 locations within each shrub island: southern side, center and northern side. All measurements were made at least once a month during the growing season (May – September) using a handheld Stevens Hydraprobe soil moisture sensor.

Root Non-Structural Carbohydrates: Several grams of root tissue were harvested at each shrub island each year prior to the shrubs leafing out and after leaf senescence. All root tissues were cleaned in DI water to remove all dirt impurities and then dried for 72 hours at 60 °C before being ground up using a Wig-L-Bug® grinder. Then all of the samples had the non-structural carbohydrates extracted and were analyzed colorimetrically using a spectrophotometer (Hendrix, 1993. *Crops Science* 6:1306 - 1311).

Fire Temperature: In watershed 4B prior to the prescribed fire 100 ceramic tiles with welder's temperature paint was placed in shrub islands and in the space between the shrubs. Each shrub island had 5 ceramic tiles placed in each cardinal direction (North, East, South, West) as well as 1 ceramic tile in the center of the shrub island. The remaining 20 tiles were placed randomly in the grassland spaces between the shrub islands. Each ceramic tile had 21 paint samples that ranged from 175 °F to 1150 °F in 50 degree increments.

GFE01

Title: Ghost Fire (formerly known as Carbon Addition Experiment): an experimental manipulation of fire effects on multi-trophic community dynamics in the ungrazed uplands of unburned and annually burned watershed of Konza Prairie

Date data commenced: 04/01/2014

Date data terminated: ongoing

Location of Sampling Stations: uplands for 2 annually burned watersheds (1D & SpB)

Experimental Methods: Ghost Fire plots are located in the uplands of 2 annually burned watersheds (1D & SpB) and 2 unburned watersheds (20B & 20C). On each watershed there are 3 blocks (4x12m) of 6 plots (2x4) each. The corners of each block are marked with a tall (2m conduit) marker. Each block has a split plot design (Figure 1) with the litter present (L+) treatment covering half the block and the litter absent (L-) treatment covering the other half. In the unburned

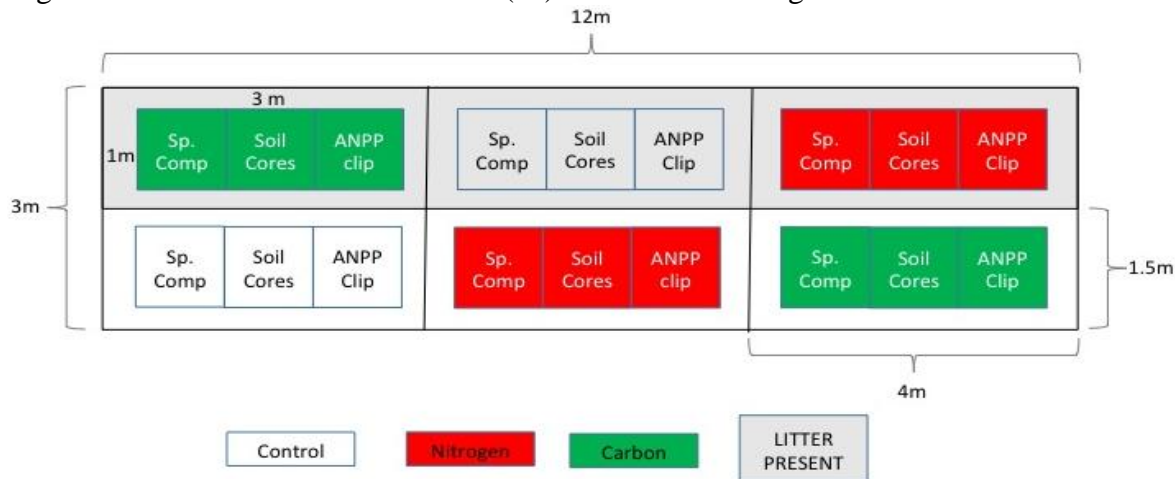


Figure 1. Split-plot experimental design. Each block is 3x12m with 6 plots inside each block.

watershed, L+ is the control, and L- is achieved removing all the litter from the plot in spring (just before average burning time) via a combination of weed whacking and raking. In the annual burn watershed, L+ is achieved by adding approximately 400 g/m² of hay from Konza which has been solarized to remove seeds immediately following burning. L- will be the control. Then nested within each litter treatment, each of the three plots is assigned one of three N treatments – Added Carbon, Control, Added Nitrogen. The added C treatment decreases N availability. The Added Carbon treatment is achieved by adding 250 g/m² of sugar to the plots on the first of the month for four months (May, June, July, August). The Added Nitrogen treatment is achieved by adding 10 g/m² of nitrogen to the plots on May 1st. Theoretically due to differences in starting soil N levels due to the long-term burning history, we add enough nitrogen to the annual burned Nitrogen plots to cause N levels to be equivalent with those found in the unburned Control plots, and nitrogen content in the Carbon treatment in the unburned will be similar to the Control in the annual burn (Figure 2). These treatments began in the spring of 2015. The corners of each plot are marked with a mid-height (1m conduit) marker.



Figure 2. Schematic of theoretical soil C:N levels. Control plots are clear, nitrogen addition are red, and carbon addition are green.

Each plot consists of three 1x1m subplots. Subplot A is the permanent species composition plot. No destructive sampling will be allowed in this subplot. Subplot A is surveyed for plant species composition twice yearly, once in the spring and once in the fall. Subplot A is marked each spring with flags. Subplot B is used for yearly ANPP sampling, as well as any other aboveground tissue sampling (e.g., for C:N leaf tissue). Subplot C is used for destructive belowground sampling of plant roots, microbial community, and soil nutrient levels. Other researchers are allowed to use subplots B and C as long as the level of disturbance caused by the sampling is deemed appropriate.

Data Collected: A range of community and ecosystem measurements are taken in Ghost Fire. Table 1 shows the data available from the first three years of sampling. Note that 2014 is pretreatment data. Not all of the samples collected have been processed yet. For example, the mycorrhizal recolonization from 2014 and the soil organic matter samples from all years have not been processed yet. Everything else from 2014 & 2015 is complete, and much of the 2016 data is still to be processed and entered at this time (December 2016).

Ideally in each year we will sample soil enzyme activity, plant species composition, plant stem density, ANPP, aboveground biomass (disc pasture meter), belowground standing crop (soil cores), light, and C:N of soil. Every 5 years we plan to conduct more intensive sampling including belowground productivity, mycorrhizal biomass, microbial biomass and community composition, insect biomass and community composition, and resin bags. Treatments and sampling will be maintained until significant plant community shifts have been observed.

Table 1. Complete list of data available from Ghost Fire from the pretreatment year (2014) and the first two years of treatment (2015 & 2016).

Measurement	2014	2015	2016	Notes
Soil Resins	X			
Soil Organic Matter (SOM)	X	X	X	This was done only in early season 2014, early & late in 2015, and late only in 2016
Soil Enzyme Activity	X	X	X	This was done only in early season 2014, early & late in 2015, and late only in 2016
Mycorrhizal Root Colonization	X			
Belowground Standing Crop	X		X	
BNPP	X			
CO ₂ Flux			X	
Plant Species Composition (Spring & Fall)	X	X	X	
Plant Stem Density by Species (Spring Only)	X	X	X	
ANPP	X	X	X	
Disc Pasture Meter		X	X	
Light	X	X	X	This was done early and late in 2014, early only in 2015, and monthly in 2016
Invertebrate Biomass	X			
Invertebrate Community Composition	X			

Data Collection Methods:

Soil (Resins): Soil available N was measured using two resin bags per plot installed early May-September. Bags were made of fine (<1 mm), undyed nylon mesh and contained 5 g each of anion exchange resin (Cl⁻ form; Dowex 1X8-100, 50-100 mesh) and cation exchange resin (H⁺ form; 50WX8-40, Dowex HCR-W2, 8% cross linking, 16-40 mesh). The day prior to installation, bags were soaked for one hour in 0.6 N HCl then rinsed with de-ionized water three times and stored at 4° C. Bags were buried 10 cm deep at the edge of Subplot C. After extraction of bags in September, measurement of available N (nitrate and ammonium) bound to resins was accomplished by first extracting N by shaking resin bags in 100 ml of 2 M KCl at 200 rpm for 2 hours and processing the solution through polycarbonate filters. Concentration of N in extracts was then measured using an Alpkem Flow Solution 4 Automated Wet Chemistry System (O.I. Analytical, College Station, TX, USA). Values from each resin bag were averaged per plot.

Soil Organic Matter (SOM): Soil organic matter is measured using the loss on ignition (LOI) method. A known weight of field-moist soil is dried overnight at 105°C, then weighed again to measure the dry weight of soil. Then the soil subsample is placed in a muffle furnace at 400°C for 2h to combust all organic material and weighed again. The soil organic matter lost on ignition is reported as a proportion (w/w) of the total dry soil mass.

Soil Enzyme Activity: Hydrolytic enzyme potential activities were measured using fluorometric substrates (MUB and methylcoumarinmethylumbelliferone/ MUB and methylcoumarin) and oxidative enzyme potential activities were measured using a colorimetric substrate (L-DOPA) in 96-well (6 – 8 technical replicates) plate assays. Hydrolytic enzyme assays included phosphatase (Phos; EC 3.1.3.1, 4-MUB-phosphate), leucyl aminopeptidase (LAP; EC 3.4.11.1, L-leucine-7-amido-4-methylcoumarin), cellobiohydrolase (CBH; EC 3.2.1.91, 4-MUB- β -D-cellobioside), β -glucosidase (β G; EC 3.2.1.21, 4-MUB- β -D-glucoside), and β -N-acetylglucosaminidase (NAG; EC 3.2.1.14, 4-MUB-N-acetyl- β -D-glucosaminide), and were run at a final substrate concentration of 40 μ M. Oxidative enzyme assays included peroxidase (Perox; EC 1.11.1.7, L-3,4-dihydroxyphenylalanine and H₂O₂) and phenol oxidase (Phenox; EC 1.10.3.2, L-3,4-dihydroxyphenylalanine) and were run at a final substrate concentration of 5 mM. All assays were run at 24°C in 50 mM sodium acetate buffer (pH 5) for 2 (β G and Phos), 4 (NAG and CBH), or 18 h (LAP, Perox and Phenox), with appropriate blank and quench controls, and final activities were standardized to nmol substrate degraded (hydrolyzed or oxidized) g⁻¹ dry soil h⁻¹.

Mycorrhizal Root Colonization: Measures of root colonization by mycorrhizal fungi are obtained from 3 pooled soil cores taken in each plot in August. The soil cores are pooled, roots cleaned and stained with trypan blue, and the percentage mycorrhizal colonized roots are determined microscopically using the gridline intersect method.

Belowground Standing Crop: Three 2 cm diameter x 15 cm depth soil cores were taken in each plot in August or September to estimate belowground root standing crop. Samples were taken randomly within the designated soil sampling subplots. Samples were kept at 4 C until processed, elutriated to remove roots from soil, and dried at 60C for 48 hours. SOM particles and dead roots (identified by color/texture) were sorted out of the sample, then the remaining live root portion was weighed. Finally, samples were combusted at 450 C for 4 hours to obtain ash masses, which were subtracted from live root mass to obtain ash free dry mass (AFDM).

BNPP: In May, two root ingrowth cores were installed in each plot. Cores were 5 cm diameter x 15cm deep, and constructed of 2 mm mesh screening. Holes were drilled into the soil using a 7” diameter bucket auger, cores were installed and both the cores and surrounding hole was filled with sieved soil from the site. Soil in and around cores was packed to approximate field conditions. Ingrowth cores were removed in September and kept at 4 C until processing. Samples were elutriated to remove roots from soil, and root contents dried at 60C for 48 hours. SOM particles were sorted out of the sample, then the remaining root samples were weighed. Finally, samples were combusted at 450 C for 4 hours to obtain ash masses, which were subtracted from root mass to obtain ash free dry mass (AFDM).

CO₂ Flux: Soil CO₂ efflux measurements were taken weekly from early June to mid-August in 2016. Measurements were taken from 2 PVC collars (10 cm diameter x 8 cm deep, buried 6 cm in the ground) per plot using a Li-Cor 6400 portable gas exchange system with a soil CO₂ chamber attachment. Collars were placed at a standardized location in all plots except when soil depth was <6 cm. Measurements were taken between 11 am and 2 pm and all aboveground living biomass was clipped prior to taking measurements. We also measured the headspace within the collars monthly and adjusted measurements to reflect this volume. CO₂ efflux measurements were recorded once values had stabilized (usually ~ 1 minute after attaching the instrument to the collar). Additionally, soil moisture and temperature were taken at each time of soil CO₂ sampling.

Plant Species Composition: Within each plot, permanent 1x1m species composition plots are designated as Subplot A. Percent aerial cover is estimated to the nearest 1% for each species that was rooted in the plot in early June and late August.

Plant Stem Density: Within each species composition plot (Subplot A), a permanent 0.1m² (20x50cm) stem density quadrat was established. Each year in early June, number of stems of each species are counted.

ANPP (Above-ground Net Primary Production): Each year between late August and early September, above-ground biomass is clipped to ground level within 2 20x50cm quadrats located in each plot’s designated destructive sampling subplot (Subplot B) and sorted into graminoids (grasses and sedges), non-graminoid forbs, woody plants, and previous year’s dead. Detailed clipping locations are recorded with Subplot B to make sure that quadrat locations are clipped as infrequently as possible. After clipping, biomass was dried at 60 °C for ca. 48 hours and then weighed. Previous year’s dead biomass (unburned years) was not included in estimates of annual productivity.

Disc Pasture Meter: Disc Pasture Meters allow for coarse estimates of aboveground biomass in a non-destructive way. Four measurements are taken in Subplot B (before ANPP is clipped), with each measurement occurring in a different corner of the plot. These are then averaged across the four subplot and using an established allometric equation, converted to g/m² of aboveground biomass.

Light: Light, sampled using a ceptometer, provides a percentage of photosynthetically active radiation that reaches the soil surface. Light is measured each year in the Spring (early June) in Subplot A. The June measure helps to determine the efficacy of the litter treatment. Additionally, this time period shows the biggest discrepancies between treatments in PAR hitting the soil surface (late in the growing season plant growth in all treatments drastically limits PAR at the soil surface). As personnel are available and time permits, other time points throughout the growing season are measured. However, these midseason and late season measurements are sporadic. Light is

measured by taking one reading above the canopy and 4 readings at the soil surface. The four measurements are then averaged and the percentage of above canopy light hitting the surface calculated.

Invertebrate Collection (Biomass & Species Composition): Invertebrates were vacuum sampled from the permanently marked productivity subplots (Subplot B) at peak invertebrate densities (August) using a modified leaf blower set. Each plot was sampled for 60 seconds. Visual counts of grasshoppers and katydids that hopped out of the plot during vacuum sampling were recorded. Sampled invertebrate communities were frozen at -20C until processed. Invertebrates from each sampled were identified to family and counted. Once identified, each invertebrate sample was dried at 60C for at least 48 hours and weighed to the nearest 0.001g. Grasshoppers and katydids were dried and weighed separately from the rest of the sample to estimate biomass of Orthoptera that hopped out of the plots, which were counted but not able to be weighed.

HRE01

Title: Environmental Heterogeneity Restoration Experiment at Konza Prairie

Purpose: We manipulated key resources that influence plant diversity in tallgrass prairie (i.e., soil depth and nitrogen availability) to increase environmental heterogeneity prior to sowing native prairie species into a former agricultural field. We compared variability in nutrient availability, aboveground annual net primary productivity (ANPP), and the composition of species between replicate plots containing soil heterogeneity manipulations and plots with no resource manipulations (n = 4 per treatment) during the first 15 year of community assembly as a test of the “environmental heterogeneity hypothesis.”

Date data commenced: 01/05/1998

Date data terminated: 12/31/2012

Methods:

Data are corresponding to subplot and whole-plot analyses of the “Prairie Restoration Heterogeneity Plots” located at the Konza Prairie Long Term Ecological Research site in Manhattan, KS USA. Subplot and whole-plot data are in different tabs (pages) labeled within the Excel file. Data include annual aboveground net primary productivity (= ANPP in file name), available nitrate (= NO₃ in file name), species diversity (= H in file name), species richness (= R in file name), and percent cover of each plant species (= SPCOV in file name).

Data correspond to an experiment that was a randomized complete block design with 4 whole-plot heterogeneity treatments replicated within each of 4 blocks (n = 16 whole plots); only the most heterogeneous (maximum heterogeneity = maxhet) and homogenous plots (control) are provided. Maximum soil heterogeneity was created using a 3 x 2 factorial combination of soil nutrient (3 levels) and depth (2 levels) manipulations; control plots contained no soil manipulations. The maximum heterogeneity plots contained a split-block design consisting of 3 vertical strips assigned to nutrient treatments (ambient=1, enriched=2 and reduced=3) and 4 horizontal strips assigned to alternating soil depth treatments (deep =1 and shallow =2). The maximum heterogeneity plots contained 2 replicates of 6 treatment combinations: deep soil at ambient (=control), enriched (=N) and reduced (=C) nitrogen availability, and shallow soil at ambient (=stone), enriched (=stoneN) and reduced (=stoneC) nitrogen availability. Each plot contained 12 subplots for sampling. Subplot data represent averages of multiple measurements within a subplot. Data corresponding to subplots 4 and 7 in plot 15 were removed after 2005 due to an herbicide application used to kill an invasive species. A period in the dataset indicates missing data.

HRE011 SUBPLOT DATA:

Aboveground net primary productivity (ANPP) was estimated by harvesting biomass from a 0.1 m² quadrat in September, at peak biomass, from each of the 12 subplots within the maximum and control whole-plot treatments. Biomass was clipped at the end of each growing season in 1998, 1999, 2000, 2005, and 2012. Biomass was dried for 1 week at

60°C, sorted into this year's and previous year's growth, and weighed. Biomass in each subplot was multiplied by 10; ANPP units are g m⁻² y⁻¹.

Relative availability of nitrate (NO₃-N = NO₃) was quantified using buried ion-exchange resins in 1998, 1999, 2000, 2005, 2006, and 2012. Resin bags were constructed of nylon and contained 10 g of strongly basic anion exchange resins. Nitrate passively collected on resins for the growing season. Two resin bags were buried in the surface 10 cm of each subplot in June or July and retrieved in September or October, depending on the year. Nitrate was extracted from resin bags by shaking each bag in 75 mL of 2 mol/L KCl. Solutions were filtered through 0.4-µm polycarbonate membranes. Resin-collected NO₃-N was determined on an OI Flow Solution IV autoanalyzer (OI Analytical, College Station, TX). Resin-collected NO₃-N units are µg/bag.

Shannon's diversity (H) was calculated for each subplot in 1998, 1999, 2000, 2003, 2005, 2006, 2009, 2011, and 2012. Diversity was calculated using the maximum cover of each species recorded during late spring and late summer plant surveys each year. Cover from two 0.25 m² permanent sampling quadrats within each subplot were averaged prior to calculating diversity using the following equation: $-\sum p \log_{10} p$, where p = the average proportional cover of each species within each subplot.

Species richness (R) was calculated for each subplot in the same year's diversity was measured. Species richness in each subplot was measured by counting the number species recorded from two 0.25 m² permanent sampling quadrats within each subplot.

The percent cover of each species (listed by scientific name acronym) was visually estimated in two permanent 0.25 m² quadrats within each subplot, then averaged for each subplot in 1998, 1999, 2000, 2003, 2005, 2006, 2009, 2011, and 2012. The average cover values in each subplot were used to calculate species richness and diversity. Species are listed using the USDA Plants Database (<http://plants.usda.gov/java/>(link is external)) acronyms unless the species could not be identified, in which case the acronym begins with UN. Full scientific names and authorities corresponding to each acronym are listed in the column description.

HRE012 WHOLE PLOT DATA:

The same response variables described for the subplots are provided for the whole-plots. Coefficients of variation in ANPP (CVANPP) and resin-collected NO₃ (CVNO₃) were calculated by dividing the standard deviation of subplots within a whole-plot by the mean (X 100). Plot-level richness was calculated by averaging the cover of all species from all subplots within a plot, then counting the total number of species. Whole-plot diversity was calculated using the average cover of each species recorded from the subplots within a plot. The average percent cover of each species was calculated from all subplots within a plot.

JST01

Title: *Juniperus virginiana* seedling trial with and without bison at Konza Prairie

Purpose: We report the results of a 30-year experiment at Konza Prairie, a mesic grassland in the Central Great Plains, under fire suppression (20-year fire return intervals) and experimental presence/absence of bison. Based on remote sensing, the land cover of deciduous trees was lower (6% grazed vs. 16% ungrazed) in bison-grazed areas. There was no difference between shrub land cover (42% grazed and 41%) and herbaceous land cover was higher in the grazed vs the ungrazed (51% grazed and 40% ungrazed). The land cover of evergreen trees (*Juniperus virginiana* L.)—which disproportionately decreases native biodiversity and increases wildfire risk—was approximately 0% with bison compared to 4% without bison. In a seedling trial of *J. virginiana* L., we found eight times greater over-winter mortality in the bison treatment. *Juniperus virginiana* seedlings were transplanted with and without bison to compare mortality rates.

Date data commenced: 11/02/2020

Date data terminated: 03/01/2021

Methods:

In the autumn of 2020, we transplanted 40 *J. virginiana* L. seedlings into catchment basins with and without bison. Seedlings were 10 to 30 cm tall and were obtained from a *J. virginiana* L. woodland from a private property located 11 miles NNE of our study site, from a location similar soil to our sites. Along a fence-line contrast, twenty were planted in an area with bison access and twenty without bison access in November of 2020. Each treatment had two 100 m long transects placed 200 m apart. Along each transect, one seedling was planted every 10 meters along the 100 m transect (n=20 seedlings for bison grazed and n=20 for ungrazed). Seedlings were revisited in December 2020, in January 2021, and in February 2021. With each visit, mortality and the apparent cause of mortality (browsed, trampling, and ripped out) were tracked. Seedling tracking was finished in February, as these treatments were scheduled to burn in the spring.

KBN01

Title: Konza Bird Nests

Purpose: This data set is a compilation of data collected by multiple researchers describing nests of 48 bird species from across Konza Prairie. Compiled and edited into consistent format by Emma B. Smith, and included in her Master's thesis. The goal of this dataset is to compile as much data on bird nests at Konza as possible. This data set includes data from other KNZ datasets CBN01 and PBG05, as well as data contributed by Page Klug, Jim Rivers, John Zimmerman, Bill Jensen, Brett Sandercock, Alice Boyle, Bram Verheijen, Bridget Sousa, Aaron Pearse, Karl Kosciuch, and Scott Hatch. These nests were found by rope dragging, opportunistically during other activities, within nest boxes, and/or via behavioral observations. We described nest contents, and some were monitored via repeated visits. Some data are freely available, and other data are restricted access, at the discretion of each individual contributor.

Date data commenced: 01/03/1972

Date data terminated: ongoing

Location of Sampling Stations: Konza Prairie

Methods:

For this thesis project, which used all of the nest data up to NestAutoID #80020. Any nests added after that point were not included in this thesis project. The individual data owners each signed a memorandum of understanding (MOU) which described their involvement with the thesis work, as well as any conditions or restrictions for use of their data. All of these MOUs are saved in the same location as this metadata document.

Converting grid cells to current watersheds

Nests with just a grid cell recorded were assigned by Emma B. Smith and Alice Boyle. We assigned these nests to watersheds based either on which watershed contained a large majority of the grid cell, or based on knowledge about each species' habitat use and the available habitat on each of the watersheds at the time. Below is a table with a list of each of the grid cells we assigned in the dataset, how many nests of each species were in the dataset in each of those grid cells, which current watersheds each grid cell were contained in, the percentage of the grid cell contained in each watershed, our reason for assigning each species to a watershed, and the watershed we assigned it to.

Changes and notes:

Part of the data from Bridget Sousa is not public available until (2030), please contact us if you have any questions.

KEE01

Title: Prairie phenology data from Konza Environmental Education Program (KEEP) since 2001

Purpose: This data represents the "phenology" or timing of observable biological processes, e.g. first day of blooming, first sighting of a migratory species, etc... as reported by volunteers with the Konza Environmental Education Program. The reports do not follow a specific experimental design and are based on the individual's knowledge and skills. Data is also available on the KEEP website (<https://keep.konza.k-state.edu/prairieecology/index.html>).

Date data commenced: 03/01/2001

Date data terminated: 09/30/2024

Location of Sampling Stations: Konza Prairie Biological Station

Methods:

Volunteers who are visiting the Konza Prairie Biological Station for either personal enjoyment (hiking, looking for wildflowers, etc.) or during their volunteer times with the Konza Environmental Education Program make note of phenological events they personally observe. These include sightings of the first blooms of specific plant species throughout the year or the first time a migrating bird or hibernating reptile was seen in the spring. A volunteer coordinator compiles the information, and it is regularly posted on the KEEP web site to inform volunteers of updates to the list.

Abbreviations: AgF=AgFields, BC=bison corral, BH=Butterfly Hill, BL=Bison Loop, Geo=Geomorphology site, GH=Godwin Hill, HH=Hokanson Homestead, HP=Hulbert Plots, HQ=Headquarters A,B,C,R, KC=Kings Creek, KCT=Kings Creek Trail, KL=Konza Lane, NT=Nature Trail, R1A=Fire Reversal annual burn, RM=RaMPs, RP=Restored Prairie, C3SA,B,C=Shane A,B,C, C1B=THP=Texas Hog Pasture, WL=West Loop, WP=White Pasture; Watersheds K&N+number+rep; (intro.) = introduced, not native.

KIC01

Title: Konza Prairie Terrestrial Arthropods Species List

Purpose: This data set is the Konza Prairie terrestrial arthropods species list. The species list has been modified since 1977 and was last modified by Ellen Welti and Anthony Joern in 2014.

Date data commenced: 1977

Date data terminated: ongoing

KFH01

Title: Konza Prairie Fire History

Purpose: To track the Konza burn history by year.

Date data commenced: 1972

Date data terminated: ongoing

Location of Sampling Stations: Konza Prairie

Frequency of Sampling: Depends on the watershed and the research objectives

Methods:

All units designated as spring burns are burned between 1 March and 5 May (April 1 \pm 31 d). Spring watershed-burning season continues until 5 May or until all scheduled watersheds have been burned. If weather conditions during this period preclude burning all scheduled units, the KPBS Director will make a decision whether certain scheduled units will a) remain unburned, or b) be burned later than 5 May. All units scheduled for fall burn are burned between 26 October and 5 December (November 15 \pm 20 d). Units scheduled for winter burn are burned between 21 January and 1 March (February 10 \pm 20 d), and summer unit burns are burned between 26 June and 5 August (July 15 \pm 20d).

Wildfires occurring due to lightning on KPBS property, due to any ignition or fires spreading on to KPBS from adjacent properties, or due to escape of a controlled burn on KPBS property are to be extinguished. If direct attack of a wildfire is judged impossible or is attempted and unsuccessful, every effort should be made to confine the wildfire to the smallest number of management units possible through the use of backfires.

1. If any watershed unit is partially burned due to a wildfire, the remainder of that unit is to be burned via prescribed fire within 14 days of the date of the wildfire.
2. If any watershed unit is burned by a wildfire in a year when it is not scheduled to be burned, the general KPBS policy is to re-set the clock and leave the unit unburned for the appropriate number of years (e.g. 4, 20) from the date of the unplanned burn. However, the KPBS Director and KPBS Advisory Committee may make a decision to alter the future fire plan for the unit depending upon research objectives, synchrony with other replicate units, etc.
3. For fire management and wildfire control on KPBS, the station is divided into sectors or blocks as follows:
 - A. Southwest ungrazed (R1A, R20A, 4A, 2A, 4B, 1B, SpA, 2B, SpB)
 - B. Southeast ungrazed (2C, FA, 20B, R20B, WA, 4F, SuB, FB, SuA, WB, 20C, 1D, 2D, R1B)
 - C. Bison West (N4A, N4C, N2A, HQD)
 - D. Bison Central (N1B, N4D, N2B, N20A, and west half of NIA)

- E. King's Creek sector (N20B, N4B, east half of N1A, and all K units)
- F. Shane Creek sector (C3SA, C3SB, C3SC, and C3A)
- G. Cattle Sector (C3B, C3C, C1A)
- H. White Pasture (WP)

These sectors are bordered by a gravel road and/or a wide (30') mowed fireguard. All other unit boundaries are bordered by a 10' wide mowed fireguard. Each year selected sections of fireguard may be mowed an additional 8' wide where prescribed burning is difficult due to high fuel loads, difficult topography, etc. Each year, the KPBS Director will post a map of the upcoming year's burn plan indicating which units are to be burned and which fireguard segments will be mowed an additional 8' in width. No research activities, markers, instruments, etc. are to be placed within 15' of the centerline of any fireguard.

Prescribed Burning Procedures

Early in each calendar year, the KPBS Director will post copies of the burn plan map and notify all researchers of the anticipated start date for spring burning and instruct them to make necessary preparations. It is the responsibility of all researchers to insure that any necessary preparations (removal of equipment/flags, protection of equipment, pre-burn sampling, etc.) are completed before the first day of spring burning. Researchers are similarly notified of potential dates for winter, summer, or fall burns at least two weeks in advance.

The KPBS site manager is responsible for securing all necessary county open burning permits each year. Burn permit numbers, code orange lists, and any additional information relevant to the prescribed burning program is posted at the fire command center desk in the KPBS Fire Station building. The KPBS site manager distributes copies of the KPBS base map and annual prescribed burning plan map to the Riley County Rural Fire Department, Riley County Police Department, Geary County Sheriff's Office, and Riley County Emergency Preparedness.

The Decision to Burn

The decision to burn or not to burn on a given day is based on weather conditions, condition of equipment, available crew size, and the location of watersheds to be burned. This decision is made only by the Burn Coordinator and may be made the day before or the morning of the planned burn. The final decision may well be made at the burn location. Burning will not take place if ANY of the following conditions have not been met:

Weather Conditions

The best conditions for burning are when wind speeds are in the range of 5-15 mph, and not gusty but steady from one direction. Wind direction must be appropriate to the watershed(s) to be burned. Ambient air temperatures should be between 35°F and 80°F, with relative humidity greater than 35%. Higher temperatures and reduced relative humidity cause fires to burn hotter and spread more rapidly, and burning should be avoided. The Burn Coordinator, or his/her designated Crew Leader is responsible for assessing temperatures, wind speeds, and relative humidity conditions in deciding whether conditions are suitable for the particular burns that are planned for that day. National Weather Service forecasts and weather radio should be checked for anticipated changes in weather patterns during the day. The passage of a front may cause a sudden and

unpredictable shift in wind direction and intensity. In marginal situations the final decision will be determined by conditions at the burn location, and will be made by the Burn Coordinator before the fire is lit. It is the responsibility of the Burn Coordinator to monitor weather conditions throughout the day.

Crew Size

Burning of watersheds requires a minimum of 12 persons: 2 truck drivers, 2 tractor drivers, 2 lead hose operators, 2 secondary hose operators, 2 swatters/rovers, and 2 drip-torch carriers. Small plots may be burned with two fire trucks stationed at opposite corners of the plot. In this case, a minimum of four (4) persons must be present: 1 driver, 2 hose operators and 1 drip-torch carrier. Additional workers are desirable when burning watersheds to patrol the perimeter of the fire with swatters. It is the responsibility of the Burn Coordinator to determine the minimum number of crew members necessary for a given burn and insure that an adequate crew size is present to safely conduct the burn. When burning watersheds, an adequate number of crew members should be present to insure that NO portions of the watershed boundary are out of view of at least one individual.

Official Burning Bans

Burning on Konza Prairie will not take place while an official county or state prohibition on burning ("burning ban") is in effect, unless Konza Prairie has obtained official permission to burn.

Pre-Fire Equipment Check

Vehicles and equipment are readied before leaving the Headquarters. Trucks and tractors must be filled with gasoline/diesel and oil. Water tanks must be full. Cans of gasoline (red) and drip-torch fuel (blue) must be full. Each unit should have a minimum of 2 drip-torches, cans of gasoline and torch fuel, 3 swatters, a shovel, a rake, and a drinking water jug. Each truck or tractor should have a tool chest and hose repair kit. Pump engine gas and oil should be checked and refilled if necessary. Pump engines should be started and run several times to see that there are no problems. Fire hose reel motors should be checked. Checks are made to ensure that both vehicle and hand-held radios are operational.

Choice of Unit to be Burned

The choice of area to be burned is often influenced by the wind direction. When burning watersheds close to Highway 177 or Interstate 70, wind direction must be away from the highway in order to minimize smoke on the road. Many Konza Prairie research units can be safely burned from several different wind directions. This also applies to small research plots. The units to be burned on a given day are selected by the Burn Coordinator. The choice of units to be burned is based on wind direction and speed, fireguard conditions, available crew size and experience, and which of the scheduled units can be burned most easily and safely given the wind direction and unit borders (e.g. units with a gravel road border should be burned on days when the gravel road is on the downwind side). Choice of unit to be burned is to be made based on these criteria only, and not on researcher preference.

Notification

The Riley County Rural Fire Department, Riley County Police Department, Geary County Sheriff's Office, and the Division of Biology Office and designated contact persons must be called and notified when burning is planned, regardless of the location of the fire. The KPBS Site Manager (or other person designated by the Burn Coordinator) is responsible for completing all necessary pre-burn notifications. When planning to burn adjacent to neighboring property, these neighbors should also be contacted, as well as leasees of cattle units, when cattle are present. After the burn, the list of people and agencies notified before the burn must be notified that the burn is complete.

Post-Fire Equipment Check

After vehicles and equipment have returned to the Headquarters after use for any prescribed burning or emergencies, fuel and water tanks should be filled, and equipment such as drip-torches, swatters, etc. redistributed to each vehicle. Hoses should be run out, checked for damage, and rewound.

KKE01

Title: The Konza-Kruger Experiment: A cross-continental fire and grazing experiment at Konza Prairie

Purpose: Compare mesic grassland responses to alterations in fire and grazing regimes in tallgrass prairie of North America and knobthorn-marula savanna in South Africa.

Date data commenced: 2006

Date data terminated: 2013

Location of Sampling Stations: N1B, N4B, N4D, N20B

Frequency of Sampling: From 2006-2013, annually (ANPP) and twice per growing season (plant species composition). From 2018 onward, every 5 years.

Methods:

Core Experimental Design. To manipulate the presence of large herbivores, we established replicate, 38.5-m² (7m diameter circular) herbivore exclosures prior to the growing season in 2005/2006 in unburned, intermediate burned (3 or 4 years), and annually burned areas at both Konza and Kruger. We established three blocks of seven exclosures with co-located paired plots open to grazing in each of the three fire treatments (n = 21 exclosures/treatment/site).

Vegetation Sampling Methods. Each year, we survey herbaceous plant community structure at the beginning and end of the growing season (Konza: June and August; Kruger: January and March) to capture peak abundance of early and late-season species, respectively. We sample vegetation in a permanent 2 X 2 m plot located within each of the full exclosures, and paired plots. The 4-m² plot is divided into four 1-m² subplots, and within each subplot, we estimate percent cover (to the nearest 1%) for each species rooted inside. We also sample herbaceous plant biomass in two ways. First, we measure ANPP each year at the end of the growing season inside each full exclosure by clipping all aboveground biomass in three 0.1 m² quadrats. Clipped biomass is separated into grass, forb, woody, and previous year's dead.

KKE02

Title: The Konza-Kruger Experiment: Net Primary Production Data (2010-2011)

Purpose: Compare mesic grassland responses to alterations in fire and grazing regimes in tallgrass prairie of North America and knobthorn-marula savanna in South Africa.

Date data commenced: 2006

Date data terminated: 2013

Location of Sampling Stations: N1B, N4B, N4D, N20B

Frequency of Sampling: From 2006-2013, annually (ANPP) and twice per growing season (plant species composition). From 2018 onward, every 5 years.

Methods:

We used comparable experimental designs and sampling procedures at both URF and KPBS. At URF we used three replicate plots (not hayed or mowed) that have been burned every 1 and 3 years in the spring, and those left unburned (N=9 plots). At KPBS, we established replicate plots in experimental watersheds burned every 1 and 4 years in the spring, and those left unburned (N=9 plots). Thus, the only difference in design between NA and SA was the intermediate burn frequency. In 2005 at both sites we established four 2x2m areas in each replicate of the 1-yr, 3-4 yr. burned, and unburned plots (N=36 subplots). We then randomly selected two of the subplots for the fertilization treatment and the other two subplots served as controls. Starting in 2006 at KPBS and 2007 at URF, we began adding 10 gN/m²/yr as NH₄+NO₃ to assess the interactive effects of fire frequency and nitrogen limitation on plant community composition, structure and dynamics. Experimental design and sampling for the proposed studies: A) the role of long-term fire regimes (without megaherbivores), B) the importance of grazing and grazing/fire interactions, and C) the role of megaherbivore diversity. Moveable exclosures (3/plot) will be used to estimate ANPP in the grazed plots. N addition subplots (2 x 2 m) will be divided into 4 1 x 1 plots, with two designated for plant species composition sampling and the other two for destructive sampling. Soil samples will be collected from areas not designated for ANPP or plant composition sampling. Note that the same annually and infrequently burned plots at Kruger and Konza will be used in (B) and (C). In addition, similar plots will be established minus the N addition subplots in the 1-yr and 4-yr burned blocks of the Buffalo enclosure for (c). Each of the 2x2m subplots was divided into four 1x1m quadrats. Annually since 2005 (prior to nitrogen addition) canopy cover for each species rooted in each quadrat was visually estimated twice during the growing season to sample early and late season species. As a surrogate for aboveground production, we measured light availability at the end of the growing season above the canopy at the ground surface in each quadrat (N=4 per subplot) using a Decagon ceptometer. Net primary production measurements: Prior to the 2005 growing season we established plots (13.7 m by 18.3 m) in ungrazed areas burned annually, at 3-4-year intervals, and unburned (n=3 per fire treatment) at both KPBS and URF. Areas with trees or large shrubs were avoided as our main goal was to evaluate responses in the herbaceous plant community. ANPP was estimated from end-of-season harvests starting in 2005 (September for KPBS, April for URF). In 10, 0.1-m² (20

cm by 50 cm) quadrats randomly located in each plot (n=30/treatment/site), we harvested the vegetation at ground level and separated it into grass, forb, and previous year's dead biomass. Samples were dried at 60°C at a constant weight. For annually burned plots, total biomass harvested represents ANPP. For the immediate and unburned sites, we calculated ANPP by summing all but the previous year's dead component. To assess the impacts of fire on ANPP in grazed areas, we established herbivore exclusion treatments in KPBS in North America and KNP in South Africa. Herbivore exclosures in grazed areas in KPBS and KNP were erected prior to the 2006 growing season. The exclosures were 7 m in diameter, 2 m tall, and constructed of diamond mesh (5-cm diameter). Seven exclosures were established in each of three blocks of the three fire treatments – annually burned, intermediate burn (3-years for KNP or 4-years for KPBS), and unburned (n=21 exclosures/treatment/site). As our focus was on ANPP responses of the herbaceous layer, exclosures were not located beneath trees or where dense shrub patches were present. Additionally, in the Satara region on KNP is a 900-ha permanent enclosure containing 80-90 adult African buffalo (*S. caffer*). This enclosure was erected in 2000 and was divided into six areas (100-200 ha each), with these burned on a rotational basis including plots burned annually and plots that were unburned. We used the unburned and annually burned areas in the buffalo enclosure to provide a direct comparison for determining the effects of a single-species large grazer in KNP and KPBS, and to assess the effects of large herbivore diversity at adjacent sites in KNP. Similar exclosures were built in the African buffalo enclosure at KNP. We placed 7 exclosures in the three blocks of each fire treatment (annually burned and unburned) resulting in 21 exclosures/treatment. We sampled ANPP by harvesting plant biomass from three 0.1 m² quadrats per herbivore exclosure at the end of the growing season starting in 2006.

Data are collected twice each year at each site. Sample periods are equivalent to spring and late summer at each study site (December/January and March/April in South Africa, May and September in North America). Where the data was collected: Ukulinga Research Farm, Pietermaritzburg, South Africa; Satara Region of Kruger National Park, South Africa; Konza Prairie Biological Station, North America.

Additional geographic metadata:

Ukulinga Research Farm (URF), South Africa. The URF of the University of KwaZulu-Natal is located in Pietermaritzburg, in southeastern South Africa (30°24'S, 29°24'E). The site is dominated by native perennial C4 grasses, such as *Themeda triandra* and *Heteropogon contortus*, that account for much of the herbaceous aboveground net primary production (ANPP). Mean precipitation is 790 mm, coming mostly as convective storms during summer (Oct-Apr). Summers are warm with a mean monthly maximum of 26.4°C in February, and winters are mild with occasional frost. Soils are fine-textured and derived from shales. There has been no grazing at this site for more than 60 years. Long-term experimental plots were established at URF in 1950 with the objective of determining the optimal fire and/or summer cutting regime to maximize hay production. The experiment is a randomized block (three replicates) split-plot design with four whole-plot haying treatments and 11 subplot fire or mowing treatments. Subplot sizes are 13.7 x 18.3 m.

Kruger National Park (KNP), South Africa. The KNP is a 2 million ha protected area of savanna grassland that includes many of the large herbivores common to southern Africa (22°25' to 25°32'S, 30°50' to 32°2'E). The extant abundance and grazing intensity of

herbivores in KNP is considered moderate for regional savanna grasslands. In the south-central region of KNP where our research takes place, average rainfall of 537 mm with most falling during the growing season (Oct-Apr). The dormant season is milk, dry and frost free, and summers are warm with mean monthly maximum air temperature of 28.9°C in January. Because of the importance of fire in savanna grassland ecosystems, the Experimental Burn Plot (ESP) experiment was initiated in 1954 to examine the effects of fire frequently (control-no fire, 1-, 2-, 3-, 4- and 6-year return interval) and season [early spring (Aug), spring (Oct), mid-summer (Dec), late summer (Feb), and fall (Apr)] on vegetation communities in the park. Four blocks of 12 plots (two were later split for 4- and 6-year trts), each ~7 ha (370 x 180 m) in size, were established in four primary vegetation types covering the two major soil types (granites and basalts) and spanning the precipitation gradient in the park. Each plot has 50+ years of known fire history, and native herbivores have had unrestricted access, thus fire and grazing effects are combined. This research focuses on the EBPs located near Satara where precipitation, soil type, and the mix of herbaceous and woody plants are similar to KPBS. Vegetation on the blocks is co-dominated by C4 grasses, which as *Bothriochloa radicans*, *Panicum coloratum* and *Digitaria eriantha*, and woody plants, such as *Acacia migrescens* and *Sclerocarya birrea*. Soils are fine-textured and derived from basalts. Adjacent to one of the Satara blocks is the Cape buffalo enclosure, erected in 2000 for veterinary purposes. The 200 ha permanent enclosure contains 65-80 animals and is divided into 4 blocks burned on a rotational basis. The grazing intensity inside is comparable to the moderate levels imposed in the park and at KPBS. Two blocks are burned annually while others are burned infrequently (approximately once every 4 years).

Konza Prairie Biological Station (KPBS), North America. The KPBS is a 3,498 ha savanna grassland in northeastern Kansas, USA (39°05'N, 96°35'W) dominated by native perennial C4 grasses such as *Andropogon gerardii* and *Sorghastrum nutans* that account for the majority of ANPP. Scattered shrub and tree species include *Cornus drummondii*, *Gleditsia triacanthos*, and *Prunus* spp. Numerous sub-dominant grasses and forbs contribute to the floristic diversity of the site. The climate is continental, which means July air temperature of 27°C. Annual precipitation is ca. 820 mm/year, with 75% falling as rain during the Apr-Oct growing season. Soils are fine textured, silty clay loams derived from limestone and shales. KPBS includes fully replicated watershed-level fire and fire/grazing treatments, in place since 1977 and 1987, respectively. Replicate watersheds (mean size ~60ha) are burned at 1-, 2-, 4-, 10- and 20-year intervals, mainly in April, to encompass a range of likely natural fire frequencies and management practices. A subset of watersheds has not been grazed for more than 30 years. To address the role of native grazers and fire/grazing interactions, bison (~260 individuals) were reintroduced to KPBS in a 1000-ha fenced area that includes replicate watersheds burned in the spring at 1-, 2-, 4- and 20-year intervals. The overall grazing intensity is considered moderate.

Study Area 1:

Study Area Name: Ukulinga Research Farm

Study Area Location: Near Pietermaritzburg, South Africa

Elevation: 840 m above sea level

Landform: Colluvium fan

Geology: Marine shales and dolerite colluvium

Soils: Dystric leptosols, Chromic luvisols, Haplic plinthisols

Vegetation: Native grassland

Climate: Mean annual precipitation is 844 mm, Mean annual temperature 17.6°C
Site history: Ungrazed since 1050
Single Point: 29°40'S / 30°20'E

Study Area 2: Kruger National Park, South Africa
Study Area Name: Satara Experimental Burn Plots and Cape Buffalo Exclosure
Study Area Location: Near Satara rest camp
Elevation: 240-320 meters above sea level
Landform Level Upland
Geology: Basalts
Soils: Rhodic nitisols, Haplic luvisols, Leptic phaeozems
Vegetation: Native grassland
Climate: Mean annual precipitation 544 mm; mean annual temperature 21.2-23.3°C
Site History: Grazed by native herbivores
Single Point: 23-25°S / 30-31°E

Study Area 3: Konza Prairie Biological Station
Study Area Name: Konza Prairie
Study Area Location: Watersheds N20B, N4D, N1B, N4B; 1D, 4F, 20B
Elevation: 320-444 meters above sea level
Landform: Alluvial terrace
Geology: Cherty limestone and shale
Soils: Udic argiustolls
Vegetation: Native grassland
Climate: Mean annual precipitation 835 mm; mean annual temperature 12.7°C
Site History: Ungrazed watersheds (since 1971), watersheds grazed by native herbivores (since 1987)
Single Point: 39°05.58'N / 96°34.12'W

KKE03

Title: The Konza-Kruger Experiment: Kruger Species Composition (2006-2010)

Purpose: Compare mesic grassland responses to alterations in fire and grazing regimes in tallgrass prairie of North America and knobthorn-marula savanna in South Africa.

Date data commenced: 2006

Date data terminated: 2013

Location of Sampling Stations: N1B, N4B, N4D, N20B

Frequency of Sampling: From 2006-2013, annually (ANPP) and twice per growing season (plant species composition). From 2018 onward, every 5 years.

Methods:

We used comparable experimental designs and sampling procedures at both URF and KPBS. At URF we used three replicate plots (not hayed or mowed) that have been burned every 1 and 3 years in the spring, and those left unburned (N=9 plots). At KPBS, we established replicate plots in experimental watersheds burned every 1 and 4 years in the spring, and those left unburned (N=9 plots). Thus, the only difference in design between NA and SA was the intermediate burn frequency. In 2005 at both sites we established four 2x2m areas in each replicate of the 1-yr, 3-4 yr. burned, and unburned plots (N=36 subplots). We then randomly selected two of the subplots for the fertilization treatment and the other two subplots served as controls. Starting in 2006 at KPBS and 2007 at URF, we began adding 10 gN/m²/yr as NH₄+NO₃ to assess the interactive effects of fire frequency and nitrogen limitation on plant community composition, structure and dynamics.

Experimental design and sampling for the proposed studies: A) the role of long-term fire regimes (without megaherbivores), B) the importance of grazing and grazing/fire interactions, and C) the role of megaherbivore diversity. Moveable exclosures (3/plot) will be used to estimate ANPP in the grazed plots. N addition subplots (2 x 2 m) will be divided into 4 1 x 1 plots, with two designated for plant species composition sampling and the other two for destructive sampling. Soil samples will be collected from areas not designated for ANPP or plant composition sampling. Note that the same annually and infrequently burned plots at Kruger and Konza will be used in (B) and (C). In addition, similar plots will be established minus the N addition subplots in the 1-yr and 4-yr burned blocks of the Buffalo enclosure for (c). Each of the 2x2m subplots was divided into four 1x1m quadrats.

Annually since 2005 (prior to nitrogen addition) canopy cover for each species rooted in each quadrat was visually estimated twice during the growing season to sample early and late season species. As a surrogate for aboveground production, we measured light availability at the end of the growing season above the canopy at the ground surface in each quadrat (N=4 per subplot) using a Decagon ceptometer. Net primary production measurements: Prior to the 2005 growing season we established plots (13.7 m by 18.3 m) in ungrazed areas burned annually, at 3-4-year intervals, and unburned (n=3 per fire treatment) at both KPBS and URF. Areas with trees or large shrubs were avoided as our main goal was to evaluate responses in the herbaceous plant community. ANPP was estimated from end-of-season harvests starting in 2005 (September for KPBS, April for URF). In 10, 0.1-m² (20

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Study Area 1:

Study Area Name: Ukulinga Research Farm

Study Area Location: Near Pietermaritzburg, South Africa

Elevation: 840 m above sea level

Landform: Colluvium fan

Geology: Marine shales and dolerite colluvium

Soils: Dystric leptosols, Chromic luvisols, Haplic plinthisols

Vegetation: Native grassland

Climate: Mean annual precipitation is 844 mm, Mean annual temperature 17.6°C
Site history: Ungrazed since 1050
Single Point: 29°40'S / 30°20'E

Study Area 2: Kruger National Park, South Africa
Study Area Name: Satara Experimental Burn Plots and Cape Buffalo Exclosure
Study Area Location: Near Satara rest camp
Elevation: 240-320 meters above sea level
Landform Level Upland
Geology: Basalts
Soils: Rhodic nitisols, Haplic luvisols, Leptic phaeozems
Vegetation: Native grassland
Climate: Mean annual precipitation 544 mm; mean annual temperature 21.2-23.3°C
Site History: Grazed by native herbivores
Single Point: 23-25°S / 30-31°E

Study Area 3: Konza Prairie Biological Station
Study Area Name: Konza Prairie
Study Area Location: Watersheds N20B, N4D, N1B, N4B; 1D, 4F, 20B
Elevation: 320-444 meters above sea level
Landform: Alluvial terrace
Geology: Cherty limestone and shale
Soils: Udic argiustolls
Vegetation: Native grassland
Climate: Mean annual precipitation 835 mm; mean annual temperature 12.7°C
Site History: Ungrazed watersheds (since 1971), watersheds grazed by native herbivores (since 1987)
Single Point: 39°05.58'N / 96°34.12'W

LPT01

Title: Leaf physiological and structural traits of encroaching shrub species at Konza Prairie

Purpose: A variety of leaf-level physiological and structural traits were collected on seven species of encroaching shrubs at Konza Prairie Biological Station during the summer of 2022. Shrub species spanned an order of magnitude in abundance. These data were used to assess if the most abundant encroaching species at Konza Prairie have common growth forms and physiology or unique traits that differentiate their carbon- and water-use strategies. Measurements included A-Ci response curves, light response curves, pressure-volume curves, specific leaf area, leaf dry matter content, leaf carbon and nitrogen content, leaf $\delta^{13}\text{C}$ and wood density. All measurements were collected on the same shrub individuals.

Date data commenced: 01/03/2022

Date data terminated: 12/31/2022

Methods:

A-Ci response curves: A-Ci response curves were measured between July 13 and July 21, 2022, using a LI-COR 6800 infrared gas analyzer. Four replicates of each species were measured in each watershed. We used the dynamic assimilation response curve method that uses dynamic equations to continuously change CO₂ concentrations from 1600 ppm to 40 ppm. Leaves were allowed to stabilize to chamber conditions before starting each curve. Initial chamber conditions were set to: CO₂ = 400 ppm, temperature = 30 °C, relative humidity = 50%, light = 2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Maximum rates of electron transport (J_{max}) and carboxylation capacity (V_{cmax}) were derived using the plantecophys package in R. Leaf area was calculated using imageJ for accurate parameter estimation.

Rapid light response curves: Rapid light response curves were measured between June 28 and July 5, 2022, using a LI-COR 6400 infrared gas analyzer. Four replicates of each species were measured in each watershed. Light intensities were set to 2000, 1600, 1200, 800, 400, 200, 100, 50, 30, 15, and 0 $\mu\text{mol m}^{-2} \text{s}^{-1}$. CO₂ inside the chamber was set to 400 ppm and relative humidity was maintained between 40-50%. Each leaf was allowed 90-200 seconds to stabilize between light intensities. We derived quantum yield (f), light compensation point (LCP), light saturated photosynthetic rate (A_{sat}) using the photosynthesis package in R. Leaf area was calculated using imageJ for accurate parameter estimation.

Pressure-volume curves: Pressure-volume curves were sampled between August 22 and August 31, 2022, using the bench dehydration method. Four replicates of each species were measured in each watershed. Terminal sections of branches were collected before sunrise between 400 and 530 hr, placed in a plastic bag with a moist paper towel, and stored in a refrigerator until measuring. All branches were collected on the same morning as they were measured. To start each curve, a portion of the stem with the youngest developed leaves were cut underwater with a razor blade and weighed. Leaf water potential was measured using a Scholander Pressure Chamber. The leaf was weighed again immediately after the water potential measurement, allowed to dry down on the bench top for 2 minutes, placed in

a plastic bag to equilibrate for 20 minutes and then water potential was measured again. This process was repeated with dry down periods of 2 minutes to 2 hours until a pressure of 3.0 to 3.5 MPa was reached. Each leaf was dried at 60 °C for 48 hours and weighed. We derived turgor loss point for each sample using the pressure volume analysis spreadsheet tool (PVASt).

Leaf functional traits: Specific leaf area (SLA) and leaf dry matter content (LDMC) were measured in late July 2022. Five leaves from five replicates of each species were measured in each watershed. The petiole and rachis of each leaf were included. Leaves were collected, placed in a moist plastic bag, and stored in a cooler until processing. We measured fresh area using imageJ. Leaves were then rehydrated overnight and measured for water saturated mass. Leaves were dried for 48 h at 60 °C and weighed them for leaf dried mass. SLA and LDMC were calculated for each individual leaf and then averaged for each individual shrub. Leaves for each replicate shrub were combined, ground, and measured for foliar C:N and $\delta^{13}\text{C}$.

Wood density: Wood density was measured in August 2022 using the water displacement method. Five replicates of each species were measured in each watershed. A 10 cm long section of stem was cut 20 cm above the ground and measured for fresh volume. Stem sections were dried at 60 °C for 72 hours and weighed to calculate stem density (mg cm^{-3}).

LTM01

Title: Herbarium and grassland sites leaf trait measurements at Konza Prairie

Purpose: Using herbarium specimens spanning 133 years and field-collected measurements, we assessed intraspecific trait (leaf structure and stomata) variability from grass species in the Great Plains of North America. We focused on two widespread, closely-related grasses from tribe Paniceae: *Dichanthelium oligosanthes* subsp. *scribnerianum* (C3) and *Panicum virgatum* (C4). Thirty-one specimens per taxon were sampled from local herbaria from the years 1887 – 2013 to assess trait responses across time to changes in atmospheric [CO₂] and growing season precipitation and temperature. In 2021 and 2022, the species were measured from eight grasslands sites to explore how traits vary spatially across natural continental precipitation and temperature gradients.

For temporal trends, we predicted $\Delta^{13}\text{C}$ would decrease in *D. oligosanthes* and exhibit no change in *P. virgatum*. *Dichanthelium oligosanthes* is a C3 species, which we predict will respond to increased [CO₂] concentrations by increasing its WUE to either conserve water while maintaining the same rates of photosynthesis or increase photosynthesis and maintain the same rates of water loss, thus decreasing $\Delta^{13}\text{C}$. We did not expect $\Delta^{13}\text{C}$ of *P. virgatum* to respond over time because discrimination in C4 species is minimally affected by [CO₂]. We also predicted both grasses will increase tissue C:N ratios and decrease stomatal density and stomatal lengths on both sides of the leaves in response to increased [CO₂] over time. Lastly, we hypothesized %N and $\delta^{15}\text{N}$ would decrease for both taxa. Because both taxa are widely distributed across North America and are known to exhibit variation in leaf morphology, we expected specific leaf area (SLA) to be greater in areas with warmer temperatures but not be correlated with differences in precipitation. We expect leaf dry matter content (LDMC) to increase with greater precipitation and decrease with higher temperatures.

Date data commenced: 06/01/2021

Date data terminated: 10/31/2022

Methods:

Research location description:

To measure temporal trends in leaf traits, we sampled 14 specimens each of *D. oligosanthes* and *P. virgatum* at the Kansas State University Herbarium (KSC) and 17 specimens each at the Ronald L. McGregor Herbarium at the University of Kansas (KANU). For the years 2021 and 2022, plants were collected in the field at Konza Prairie Biological Station, Kansas and pressed and dried before sampling.

To compare how *D. oligosanthes* and *P. virgatum* leaf traits vary across grasslands of the Great Plains of the United States, we sampled individuals from eight sites over the summers of 2021 and 2022: (1) Woodworth Station Waterfowl Production Area, North Dakota, (2) Cedar Creek Ecosystem Science Reserve, Minnesota, (3) Valentine National Wildlife Refuge, Nebraska, (4) T. L. Davis Preserve, Nebraska (5) Kish-Ke-Kosh Prairie, Iowa, (6)

Konza Prairie Biological Station, Kansas, (7) Wah'Kon-Tah Prairie, Missouri, and (8) Joseph H. Williams Tallgrass Prairie Preserve, Oklahoma.

At each grassland site, one to nine replicates of each species (with most sites having 5 replicates) were measured for their specific leaf area (SLA), leaf dry matter content (LDMC), leaf thickness, C:N, $\delta^{13}\text{C}$, stomatal density, and stomatal length using standardized sampling methods. For leaf measurements (SLA, LDMC, and leaf thickness), the most recently produced, but mature leaf was sampled from each replicate. Leaf area and leaf thickness were measured in the field. Leaf area was measured using Leafscan, a mobile app for measuring the surface area of leaves and leaf thickness using calipers. To calculate LDMC, leaves were rehydrated by being submerged in water for 24-72 hours for wet mass measurements and dried in a drying oven at 60 °C for at least 48 hours for dry mass. Stable isotope measurements for leaf $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, total C, and total N were performed at the Stable Isotope Mass Spectrometry Laboratory at Kansas State University. Multiple leaves from each replicate were dried for at least 48 hours at 60 °C and homogenized with an amalgamator. Total C and N of homogenized leaf samples were measured using an Elementar vario Pyro cube coupled to an Elementar Vision mass spectrometer for isotope analysis.

For temporal trends, all $\delta^{13}\text{C}$ values were corrected for changes in atmospheric $\delta^{13}\text{C}$ by converting to carbon isotope discrimination values $\Delta^{13}\text{C}$. Atmospheric [CO₂] and $\delta^{13}\text{C}$ air measurements were retrieved from McCarroll & Loader (2004) for the years preceding 2004 and measurements from the Mauna Observatory Data were used for years 2004 – 2022 (Keeling et al., 2005).

We measured stomatal density and length using stomatal peels on herbarium samples and pressed and dried field samples collected from each study site. Stomatal peels were created by applying clear nail varnish to leaves of the specimens and peeling the varnish once dry with clear tape. Both *D. oligosanthes* and *P. virgatum* are amphistomatous, so peels were made on both the abaxial and adaxial surfaces of the leaves. For herbarium specimens, the leaves of *P. virgatum* were long and folded to fit on the mounting sheet, exposing both sides of the same leaf. Thus, abaxial and adaxial peels were taken from the same leaf where the leaf was folded. For *D. oligosanthes*, the leaves were short and not folded to fit on the herbarium sheets, so only one side of each leaf was readily available to perform peels. To circumvent this issue, peels of the abaxial and adaxial surfaces were made on different (but similarly-developed) leaves of the same individual. For field-collected material, abaxial and adaxial peels were taken from the same leaf.

Two counts of stomatal density were taken for each peel, and five replicates of stomatal lengths were measured for each count of stomatal density (10 total per specimen). Stomata were counted under 20x magnification on the objective lens and 10x magnification on the ocular lens using an Olympus BH-2 Microscope (Shinjuku City, Tokyo, Japan). An image was taken of each leaf section using a Lumenera Infinity 2 microscopy camera (Ottawa, Canada). The area of the image field of view was determined by using a stage micrometer and was 0.120 mm² for each image. Stomatal densities were then converted to stomata per 1 mm². Total stomatal density was measured as the sum of the abaxial and adaxial stomatal densities. Stomatal length (horizontal length of the guard cell from end to end) was measured using ImageJ; pixel length was converted to mm using a reference length

determined from the stage micrometer. Five herbarium specimens of *P. virgatum* that were measured for stable isotopes were unable to be sampled for stomatal densities or lengths, as either the specimens had leaves that were too curled or wrinkled to obtain peels, or stomata were too sunken and not visible on the peels. Additionally, we note that because leaves shrink during dehydration, these measurements are likely overestimations of stomatal densities and underestimations of stomatal lengths compared to fresh leaf tissue. However, because all tissue in this study was dry, the values are all comparable.

The four corresponding R scripts can be found here:

R Code for the Herbarium Leaf Trait Analysis (Stomatal Traits): http://lter.konza.ksu.edu/sites/default/files/data/LTM011_Rscript.R
R Code for the Herbarium Leaf Trait Measurements (Non-Stomatal): http://lter.konza.ksu.edu/sites/default/files/data/LTM012_Rscript.R
R Code for the Grassland Sites Leaf Trait Measurements (Stomatal): http://lter.konza.ksu.edu/sites/default/files/data/LTM013_Rscript.R
R Code for the Grassland Sites Leaf Trait Measurements (Non-stomatal): http://lter.konza.ksu.edu/sites/default/files/data/LTM014_Rscript.R

NGE01

Title: Chronic Addition of Nitrogen Gradient Experiment (ChANGE): Assessing threshold responses of plant community composition and ecosystem processes at Konza Prairie

Purpose: To assess threshold responses of tallgrass prairie plant community composition and ecosystem function to a gradient of nitrogen addition.

Date data commenced: 2013

Date data terminated: ongoing

Location of Sampling Stations: R1B

Block Locations:

Block A 39° 05'169" N 096° 33'309" W

Block B 39° 05'174" N 096° 33'292" W

Block C 39° 05'197" N 096° 33'267" W

Block D 39° 05'209" N 096° 33'253" W

Block E 39° 05'208" N 096° 33'270" W

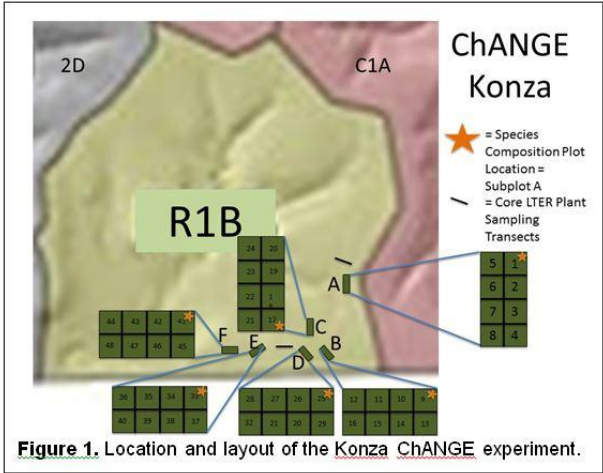
Block F 39° 05'217" N 096° 33'258" W

Frequency of Sampling: Annually (ANPP), twice-annually (plant species composition), weekly to bi-weekly (soil CO₂ flux, light measurements, soil nutrients and microbial communities)

Variable Measured: ANPP, plant species composition, soil CO₂ flux, light availability, soil N availability, soil microbial community

Methods:

Forty-eight 5 x 5 m plots were established in June 2013 in R1B in 6 blocks, with 8 plots per block (Fig. 1). Each plot is divided into four 2.5 x 2.5 m subplots. One subplot is used for core experiment measurements (species composition, ANPP, soil N availability, light availability, soil CO₂ flux and other measurements). The remaining 3 subplots are set aside for future studies by the PIs (e.g. insect herbivory monitoring and manipulations), as well as other Konza investigators. In 2013, pretreatment species composition and ANPP data were collected. In 2014 the nitrogen manipulations began. Each plot within a block receives a different nitrogen addition treatment: 0, 2.5, 5, 7.5, 10, 15, 20, or 30 g m⁻² as slow time-release Urea. Plant community composition is measured in early and late growing season by estimating the aerial cover to nearest 1% in a permanent 1 x 1 m plot located within the core subplot of each 5 x 5 m plot. Productivity is measured by clipping all aboveground biomass within two 20 x 50 cm quadrats in the core subplot of each 5x5m plot at the end of each growing season.



Quality Assurance: Entered data is checked twice

NUT01

Title: Nutrient Network: Investigating the roles of nutrient availability and vertebrate herbivory on grassland structure and function

Purpose: To collect data from a broad range of sites in a consistent manner to allow direct comparisons of environment-productivity-diversity relationships among systems around the world. This is currently occurring in each site in the network and, when these data are compiled, will allow us to provide new insights into several important, unanswered questions in ecology.

To implement a cross-site experiment requiring only nominal investment of time and resources by each investigator, but quantifying community and ecosystem responses in a wide range of herbaceous-dominated ecosystems (i.e., desert grassland to arctic tundra).

Date data commenced: 05/01/2007

Date data terminated: ongoing

Location of Sampling Stations: 30 experimental plots described below

Methods:

The NutNet methods used at Konza are copied below, modified from the Nutrient Network website. More information can be found at nutnet.org/methods.

1. Site Selection – The Konza NutNet site was selected to be relatively homogeneous (i.e., not encompassing large gradients), dominated by herbaceous vegetation, and representative of the tallgrass prairie ecosystem.

2. Observational Study – The observational data is composed of the pre-treatment sampling of all 30 experimental plots described below. At Konza, this data was collected in 2007.

3. Experimental Design - The core experiment was set up in a completely randomized block (environmental gradient) design with three blocks, 10 treatments per block, and three replicates per treatment (N = 30 total experimental units). Each experimental unit are 5 x 5 m in size, with 1-m walkways between plots and 2-m walkways between blocks. The corners of the plots are permanently marked.

Experimental units are subdivided into 4 2.5 x 2.5 m subplots (designated A,B,C,D). These four subplot are assigned to be used for the core sampling, site-specific studies, or one of two possible future studies. Each of the four 2.5 x 2.5 m subplots is further subdivided into 4 1 x 1 m sub-subplots (1,2,3,4). Thus a specific location in the plot is designated by number, letter, number combination (e.g., 21A2, 13B4, etc).

To assess multiple resource limitation, three nutrient addition treatments (Nitrogen, Phosphorus, Potassium plus Other nutrients), each with two levels (Control, Added), are crossed in a factorial design, for a total of 8 treatment combinations. Nitrogen was added in

the form of ammonium nitrate in 2008 and time-released urea thereafter. Phosphorus is added in the form of super phosphate, and potassium is added in the form of potassium sulfate. Each nutrient is applied at 10 g m⁻² in the spring of each year.

In addition, there is an herbivore fencing treatment, in which the entire 5 x 5 m plot will be fenced to exclude most herbivores. This treatment is crossed with the Control and NPK+ treatments to assess top-down vs. bottom-up effects on community structure and function.

4. Core Sampling Methodology - The core sampling 2.5 x 2.5 m subplot is divided into four 1 x 1 m permanent subplots, surrounded by a 0.25 m buffer. One of these permanent 1-m² subplots is designated for plant species composition sampling and the other three for destructive sampling. Core sampling includes aboveground standing crop (sorted to at least three functional groups), percent cover of all plant species, and light availability measurements. All of these core measurements was collected from all plots prior to initiation of the experiment and in each year of the experiment, using the same methodology as all NutNet sites.

a. Plant Species Composition

Percent aerial cover was estimated in one permanently marked 1-m² subplot within the core-sampling subplot. Aerial cover was estimated for each plant species separately using a modified Daubenmire method (Daubenmire 1959), in which cover is estimated to the nearest 1% percent for each species rooted within the plot. Percent cover was also estimated for bare soil, animal diggings/disturbance, and rocks if present. Note that total cover will typically exceed 100% because species cover is estimated independently for each species.

Within-season sampling frequency was adjusted based on the phenology of the component species in order to capture the maximum cover of each species. Species composition was measured in the spring (late-May) and again in the fall (late-Aug) to capture maximum relative cover of early-season C₃ forb and grass species and late-season C₄ forb and grass species, respectively.

b. Light Availability

Light availability was measured using a light meter (1-m length ceptometer) capable of integrated measures of photosynthetically active radiation (PAR, μmol m⁻² sec⁻¹). Light availability was measured at the same time and in the same 1-m² subplot used for the species composition measurements. Light readings were taken on a cloudless day as close to solar noon as possible (i.e., 11 am to 2 pm). For each subplot, two light measurements at ground level (at opposite corners of the 1-m² plot, diagonal to each other) and one to two above the canopy were taken. Light availability was calculated as the ratio of PAR below and above the canopy.

c. Aboveground Standing Crop

Aboveground standing crop was estimated destructively by clipping at ground level all aboveground biomass of individual plants rooted within a 0.2 m² (two 20 x 50 cm strips)

area. Biomass was clipped within the 1-m² subplots designated for destructive sampling within the core sampling subplot. Location of the quadrats was noted to prevent resampling during the duration of the study. For shrubs and subshrubs rooted within the quadrat, leaves and current year's woody growth were collected.

Standing crop was separated into the following categories: 1. previous year's dead, 2. current year's graminoid (grasses, sedges, rushes), 3. current year's forbs, and 4. current year's woody growth. All biomass was dried at 60°C for 48hrs prior to weighing to the nearest 0.01 g.

OMB01

Title: Microbial biomass at Konza Prairie (1989-1999)

Purpose: Monitor long-term change in microbial biomass due to the effect of annual burning, mowing and nitrogen and phosphorus fertilization.

Date data commenced: 04/15/1989

Date data terminated: 12/02/1999

Location of Sampling Stations: HQC

Frequency of Sampling:

Three times a year for microbial biomass and inorganic-N: pre-burn (April), post-burn (June), and fall (October).

Variable Measured:

1. Microbial biomass C and N
2. Inorganic-N
3. Soil water content

Methods:

Determination of soil microbial biomass carbon and nitrogen:

Microbial biomass C and N are determined by the fumigation-incubation method (Jenkinson and Powlson, 1976). Soil (25 g) is added to two 125 mL Erlenmeyer flasks. When the gravimetric soil water content is less than 0.26 kg kg⁻¹, enough water is added to bring the soil water content to this level. Both samples are pre-incubated at 25°C for five days. At the end of the preincubation period, one of the samples is fumigated with chloroform. Samples are placed in a vacuum desiccator that has a wet paper towel in the bottom and a beaker with approximately 50 mL of ethanol-free chloroform and nonvolatile granules for distillation. Vacuum is applied three times for approximately 30 seconds to allow the chloroform to boil. Immediately after the last application of vacuum, the desiccator is tightly closed for 20-24 hours to allow for diffusion of the chloroform into the soil. After 20-24 hours, the beaker with chloroform and the wet paper towel are removed, and the desiccator is evacuated eight times for three minutes each time. Fumigated and unfumigated samples are placed into 940 mL mason jars that have water at the bottom to maintain a highly humidified environment. Jars are tightly closed, and the samples are incubated for 10 days at 25°C. At the end of the incubation period, the CO₂-C concentration in the headspace of the mason jars is measured using a Shimadzu GC-8A gas chromatograph (Shimadzu Scientific Instruments Inc., Columbia, MD) equipped with a 2 m Porapak Q column and operated at 70°C with an He carrier gas flow rate of 14 mL minute⁻¹. After measuring CO₂-C, 100 mL of 1M KCL are added to the erlenmeyer flasks and the flasks are shaken for one hour in an orbital shaker at 300 rpm. The suspension is transferred to 250 mL centrifuge bottles and centrifuged at 16,000 g for ten minutes. After centrifugation, the supernatant is filtered through a nylon mesh (10µm) and analyzed for NH₄ -N and NO₃ -N. Nitrate-N + nitrite-N are determined by the Griess-Ilosvay technique (Keeney and Nelson, 1982), and ammonium-N by the salicylate-hypochlorite

method (Crooke and Simpson, 1971), both implemented on an Alpkem Autoanalyzer (Alpkem Corp., Clackamas, OR).

We express microbial biomass C and N as carbon (C_f) and nitrogen (N_f) flush, the difference in CO_2 -C evolved and N mineralized between fumigated and unfumigated samples, to avoid the confusion of using different conversion factors (k_c and k_n). When comparing it to other data, we calculate microbial biomass C (MBC) and N (MBN) as suggested by Voroney and Paul (1984):

$$MBC = \frac{C_f}{0.41}$$

$$MBN = \frac{N_f}{k_n}$$

where: $k_n = -0.014 (C_f/N_f) + 0.39$

C_f = CO_2 -C evolved from the fumigated treatment; units = $mg\ C\ kg^{-1}$ dry soil

N_f = $NH_4^-N + NO_3^-N$ mineralized in the fumigated treatment; units = $mg\ N\ kg\ dry\ soil$

Determination of soil inorganic N:

Inorganic-N ($NH_4^-N + NO_3^-N$) is determined at the same sampling dates as microbial biomass C and N. Soil (20 g) is extracted with 100 mL 1M KCl by shaking for one hour in an orbital shaker at 300 rpm. The suspension is transferred to 250 mL centrifuge bottles and centrifuged at 16,000 g for 10 minutes. After centrifugation, the supernatant is filtered through a nylon mesh (10 μ m) and analyzed for NH_4^-N and NO_3^-N . Nitrate-N + nitrite-N are determined by the Griess-Ilosvay technique (Keeney and Nelson, 1982), and ammonium-N by the salicylate-hypochlorite method (Crooke and Simpson, 1971), both implemented on an Alpkem Autoanalyzer (Alpkem Corp., Clackamas, OR). Inorganic N ($NH_4^-N + NO_3^-N$) is expressed as $mg\ N\ kg\ dry\ soil$.

Determination of soil water content:

Soil water content is determined gravimetrically. Soil samples, approximately 10 g, are weighed into pre-weighed moisture tins and dried for at least 24 hours at 105°C. The samples are then weighed to determine the weight lost. Water content is expressed as $g\ g^{-1}$ dry soil.

OMS01

Title: Microbial and soil data in the Belowground Plot Experiment at Konza Prairie since 2017

Purpose: To access the recovery of several ecosystem components to long-term annual addition of nitrogen fertilizer.

Date data commenced: 04/2017

Date data terminated: 09/2017

Location of Sampling Stations: Belowground Plot Experiment (HQC)

Frequency of Sampling:

Approximately every 5 weeks, starting in April 2017 and concluding in September 2017.

Variable Measured: Soil chemistry variables: Amount of ammonium (NH₄) and nitrate (NO₃) sorbed to resin beads, extractable carbon (C) and nitrogen (N), total soil carbon and nitrogen, field water content, and soil pH.

Microbial variables: Potential rates of nitrogen cycling transformations, microbial respiration, microbial biomass, abundance of nitrogen cycling genes and total bacterial 16S, alpha diversity, associated NMDS scores from Bray-Curtis dissimilarity, and abundance of common (at least 0.10% on average) phyla and classes.

Field Methods:

Four 2 cm diameter, 20 cm depth mineral soil cores were collected sterilely from each plot, or from 1 from each subplot, and combined to make 1 composite sample per plot. Composite samples were aseptically sieved to 4 mm. Subsamples of ~ 15 g were stored at -80 centigrade for molecular work, ~ 50 g stored at -20 centigrade for soil chemistry, and the remaining sample at 5 centigrade for the N cycling potential assays. Resin bags were installed in June and were removed in September.

Laboratory Methods:

The amount of NH₄-N and NO₃-N sorbed to resin bags were determined by first adding 5 g of cation and anion resin beads each in nylon bags and burying the bags to depths up to 10 cm (Baer & Blair 2008, *Ecology* 89(7): 1859-1871). Four resin bags per plot were then installed in June and removed in September. The inorganic nitrogen was quantified using a modified indophenol methods and VCl₃/Griess reagent method (Hood-Nowotny et al. 2010, *Soil Sci. Soc. Am. J.* 74(3): 1018-1027) and measured spectrophotometrically using a FilterMax F5 Multimode Microplate Reader. Extractable dissolved organic C and extractable inorganic N was measured with unfumigated soil, while the difference in extractable dissolved organic C and extractable inorganic N in soils fumigated by chloroform for 24 hours were assumed to reflect microbial biomass C and N (Brookes et al. 1985, *Soil Biology and Biochemistry* 17(6): 837-842; Vance et al. 1987, *Soil Biology and Biochemistry* 19(6): 703-707). Dissolved organic C was quantified via combustion using a Shimadzu TOC Analyzer. Total soil %C and %N were measured using a LECO TruSpec CN Combustion Analyzer. Soil field water content was estimated

gravimetrically by drying soil overnight at 105 centigrade. Soil pH was estimated by suspending field moist soil in 1:1 solution with deionized water and measuring the pH of the soil slurry solution. Nitrification potential was estimated by measuring the change in NO₃-N concentrations in 24 hours in aerobic soil slurries at saturating NH₄-N concentrations (Taylor et al. 2010, *Appl. Environ. Microbiol.* 76(23): 7691-7698). Denitrification potential was estimated by measuring the change in N₂O-N concentrations in 4 hours in anaerobic soil slurries with acetylene added to prevent the reduction of N₂O to N₂. Denitrification enzyme activity was measured similarly except soil slurries were amended with glucose and KNO₃ and only incubated for 1.5 hours (Groffman et al. 1999, *Standard Soil Methods for Long-Term Ecological Research*. 272-288). N₂O-N was quantified using a Shimadzu 2014 GC Analyzer. Microbial C respiration was estimated by trapping the overhead CO₂-C accumulated in a sealed incubation chamber from sieved soil for 1-3 hours at room temperature (Zeglin and Myrold 2013, *Soil Sci. Soc. Am. J.* 77(2): 489-500) and measuring the CO₂-C concentration using a Picarro G2101-i 13CO₂ Analyzer. N cycling gene abundances were estimated using standard protocols and primers using a Bio-Rad CFX CONNECT system (Rotthauwe et al. 1997, *Appl. Environ. Microbiol.* 63(12): 4704-4712; Francis et al. 2005, *PNAS* 102(41): 14683-14688; Mosier and Francis 2008, *Environ. Microbiol.* 10(11): 3002-3016; Henry et al. 2006, *Appl. Environ. Microbiol.* 72(8): 5181-5189; Sanford et al. 2012, *PNAS* 109(48): 19709-19714; Fierer et al. 2005, *Appl. Environ. Microbiol.* 71(7): 4117-4120; Zeglin et al. 2016, *Environ. Microbiol.* 18(1): 146-158).

Bacterial + archaeal taxa (scope) were estimated using primers (515F/806R) designed to amplify the V4 region of the 16S rRNA gene via PCR. Sequencing was performed with Illumina MiSeq Technology, and QIIME 1 bioinformatics software was used to demultiplex, join, and denoise the raw data. Operational taxonomic units (OTUs) were set at 97% similarity, and OTUs were aligned using the GreenGenes 16S rRNA gene reference database. Listed taxa are classified by either phylum or class.

Form of data output: Raw data have been converted to ecologically meaningful units using the mass of dry soil or resin bags used in assays.

Quality assurance: Negative blanks and no template controls were used for quality assurance.

Instrumentation: FilterMax F5 Multimode Microplate Reader (Molecular Devices, San Jose, CA, USA); Shimadzu TOC analyzer (Shimadzu Scientific Instruments, Inc., Columbia, MD, USA); LECO TruSpec CN Combustion Analyzer (LECO Corporation, St. Joseph, MI, USA); Shimadzu 2014 GC Analyzer (Shimadzu Scientific Instruments, Inc., Columbia, MD, USA); Picarro G2101-i 13CO₂ Analyzer (Picarro, Santa Clara, CA, USA); Bio-Rad CFX CONNECT system (Bio-Rad Laboratories, Hercules, CA, USA).

OPD01

Title: Konza Prairie standing dead and litter decomposition (1981-1983)

Purpose: Standing dead and litter decomposition of big bluestem foliage and flowering stems were measured for two years using litterbag methods. Mass, nitrogen and phosphorus content were measured.

Date data commenced: 10/31/1981

Date data terminated: 10/26/1983

Location of Sampling Stations: 004B, 000B, Florence and Tully soils (1981-1983)

Frequency of Sampling:

Stratified by watershed and soil type. 400 bags placed in field at beginning. 5-10 harvested quarterly for first year and every 6 months during the second year.

Variable Measured: Date, location, length of time in field, initial and final weight, matter type

Methods:

Air dry wts – (foliage and stems, separately) recorded prior to placement in field, reweighed after harvest. Tissues ground, Kjeldahl digest and sent to soils testing lab for N and P analysis.

Preliminary Calculations:

Initial dry mass and N and P content calculated from subsample harvested immediately after placement in fields.

PBG01

Title: Plant species composition in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated PVC021x)

Purpose: To determine long-term changes in canopy cover, frequency, richness, and diversity in pastures that are rotationally burned and seasonally grazed by cows.

Date data commenced: 5/1/2008*

Date data terminated: ongoing

*Pre-treatment data was collected in 2008 from all units except C1SB (a, b, c, d), C03A (c, d) and C03C (a, b). Data was collected all units in 2009. Cattle grazing started in 2010 in C03A/C03B/C03C and C01A and in 2011 in C3Sa/C3SB/C3SC and C1SB.

Location of Sampling Stations:

Plant composition is determined on upland topographic locations.

Sampling History:

Collection of plant composition data began in 2008.

Frequency of Sampling:

Plots are sampled twice each year (late-May to Mid-June for the spring census, and late-August to early-September for the summer census). Generally, cool-season species are sampled in the spring census whereas warm-season species are sampled in the summer census when they are more developed.

Variable Measured:

Estimated canopy cover of all vascular plant species in each plot

Methods:

In each pasture, four 50-m long transects (A, B, C, and D) were established in similar soil types and elevation. Five evenly spaced, permanently marked plots are located in each transect (n= 20 plots for each pasture). A surveyor's pin with a 1.78 m long chain is placed in the conduit marking each plot. Canopy cover of all vascular plant species in a 10-m² circular area surrounding each conduit are estimated using a modified Daubenmire cover scale (Bailey and Poulton, 1968. Ecology 49:1-13). Cover categories are:

<u>Class</u>	<u>Cover</u>	<u>Mid-point</u>
1	<1%	0.5%
2	1-5%	3.0%
3	5-25%	15.0%
4	25-50%	37.5%
5	50-75%	62.5%
6	75-95%	85.0%
7	95-100%	97.5%

Form of Data Output:

Raw data contains the cover class value for each species detected in the plot. A value of 1 to 7 indicates the estimated cover class value for the species.

For species that are sampled on both census dates, the highest cover class of each plot is used for analyses. Percentage cover for each species is computed by averaging the mid-points of the cover classes for the 20 plots. The presence or absence of a species in the 20 plots can be used to estimate frequency of occurrence.

PBG02

Title: Aboveground primary productivity within permanent and rotating grazing exclosures in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated PEB011x)

Purpose: To determine long-term effects of cattle grazing on aboveground primary production.

Date data commenced: 05/01/2010

Date data terminated: ongoing

Location of Sampling Stations:

There are four exclosures on Florence soils and four exclosures on Tully soils in each of the following grazed watersheds: N01a, N01b, N04a, N04d (total=32). Exclosures in N01a and N04a were erected in March, 1988 and were first sampled in 1992. Exclosures in N01b and N04b were erected in April, 1992 and were first sampled in 1995.

Frequency of Sampling: Once per year at peak biomass (September to October)

Variable Measured: Aboveground biomass of grass, forbs and woody and p.dead.

Methods:

An exclosure is 5 m X 10 m and constructed of fence posts and sturdy cattle paneling. One half (5 m X 5m) has been designated as the permanently ungrazed treatment; it has not been grazed since 1988 (N01a & N04a) or 1992 (N01b & N04d). It is marked with pink poles. The other half is the grazed section; it is marked with blue poles. Every six years a new grazed area is closed off and animals will not have access to this section for six years. At the end of six years, this section will be reopened to grazing and a new section is closed off. The grazed section moves in a clock-wise pattern around the permanently ungrazed section.

Sampling methods are identical to PAB01 except five 0.1m² plots randomly located within each section, grazed vs. ungrazed; total 10 samples per exclosure. Grazed and ungrazed sides of the exclosure are clipped at the same time. The plant biomass for each clipped plot is bagged, dried at 60° C and weighed. Samples are not kept for further analysis.

Summary of Changes:

2010: All pens were constructed in spring 2010. Two pens per watershed. Pens 1-8 (0c3a, 0c3b, 0c3c, 0c1a) were sampled in 2010.

2011: Pens 9-16 (c1sb, c3sa, c3sb, c3sc) were constructed in 2010, but not sampled until 2011 because cattle were not introduced.

2016 (March): grazed sections of pens 1-8 were moved 90° clock-wise

2017: Grazed section of pens 9-16 moved 90° clock-wise

2021 (December): Moved grazed sections of pens 1-8, 90° clock-wise. Installed carabiner clips in one corner to allow for easier and safer entry into pens.

2022 (November): Moved grazed sections of pens 9-16, 90° clock-wise. Installed carabiner clips in one corner to allow for easier and safer entry into pens.

PBG03

Title: Disk pasture meter measurements to estimate plant standing biomass in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated PPM011x and PPM012x)

Purpose: To estimate aboveground biomass using vegetation structure height profiles in eight grazed watersheds of varying burn history.

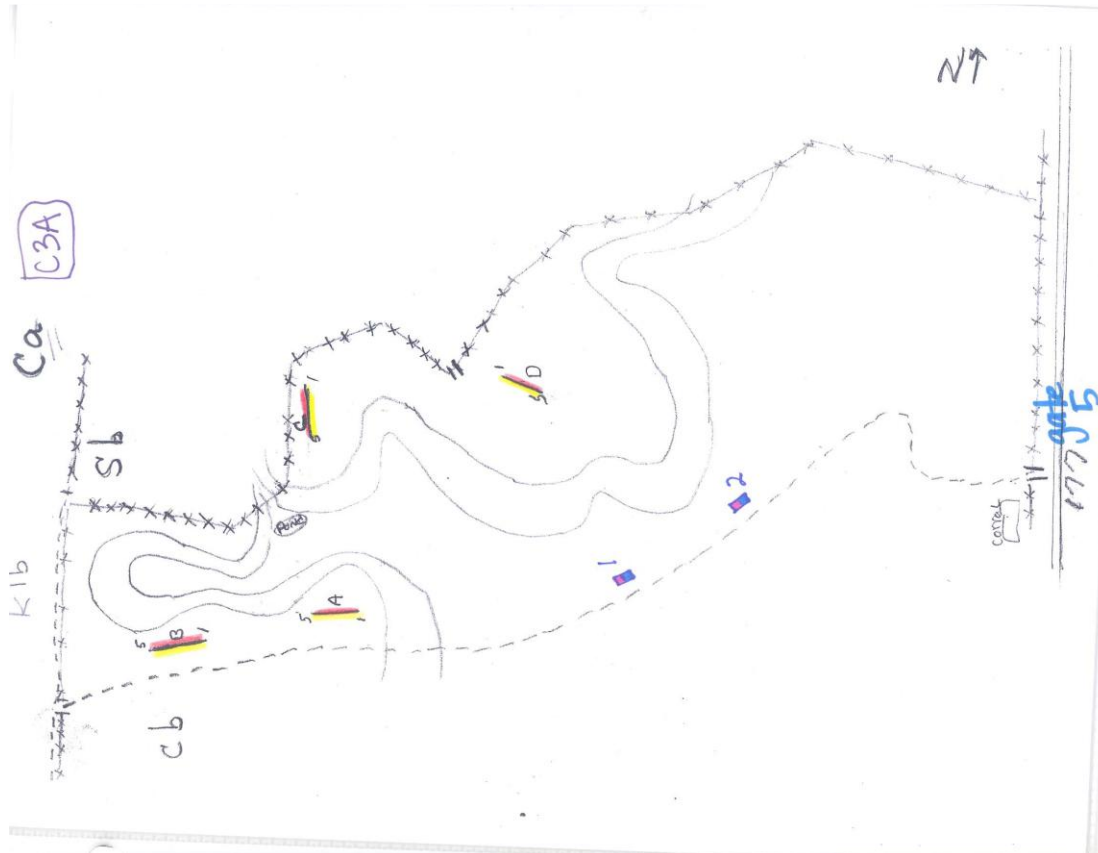
Date data commenced: 01/05/2011

Date data terminated; ongoing

Location of Sampling Stations:

Measurements were taken at a total of 64 transects (8 watersheds X 4 sites per watershed X 2 pasture meter transects per site). Each cattle-grazed watershed (designated as of May 2011 C2A, C3B, C3C, and C1A) includes 4 plant composition sampling transects (A-D). Pasture meter measurements were taken along two transects adjacent and parallel to the plant composition transects in each of these watersheds. Standing biomass samples for pasture meter calibration were also collected near the plant composition transects in the same 8 watersheds.

For example: In watershed C3A, there are 4 plant composition transects (labeled A-D). Two pasture meter transects (50 m) will be placed at each of these sites.



Frequency of Sampling:

Sampling occurred annually in late summer or early fall. The first measurements were taken in August 2010.

Variable Measured: Standing biomass, vegetation structure height

Methods:

Measurements of vegetation structure height were taken along two 50m transects approximately 25m on either side of and parallel to each of the 32 designated plant composition transects. A disc pasture meter was used to take 50 measurements per transect (1 measurement per meter). The disc apparatus was raised to the top of the measuring stick, released, and allowed to settle on the standing vegetation. The height of the vegetation in centimeters was then read from the measuring stick.

To calibrate the pasture meter, standing biomass was collected at 25-30 different locations across multiple watersheds. Care was taken to ensure the samples included a wide range of standing biomass. First, a vegetation structure height measurement was taken and recorded. Then, a circular clipping frame was placed in the same location and all biomass in the ring was clipped, bagged, dried, and weighed. These data were then used to create a regression relationship between standing biomass and vegetation structure height. The resulting equation can then be used to estimate standing biomass along each of the vegetation structure height transects.

PBG04

Title: Reproductive effect of Big Bluestem, Indiangrass and Little Bluestem in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated PRE021x and PRE022x)

Purpose: To estimate seed reproduction, flowering stem mass, height, and population densities of three dominant prairie grasses: Andropogon gerardii (ANGE), Sorghastrum nutans (SONU), and Schizachyrium scoparium (ANSC) in the Konza Prairie LTER watersheds.

Date data commenced: 05/01/2011

Date data terminated: ongoing

Location of Sampling Stations:

Florence and Tully locations of un-grazed watersheds: 001d, R01a, R01b, 002c, 002d, 004a, 004b, 020b, R20a, R20b, 0SpA, 0SpB, 0SuA, 0SuB, 00FA, 00FB, 00WA and 00WB. Sampling is done 2-3 m away from the permanently marked species composition transect.

Frequency of Sampling:

Once per year at the time of seed maturation (Oct to Nov).

Variable Measured:

1. Flowering stem heights (in centimeters)
3. Density of flowering stems (No. per m²)
4. Weight of flowering stems (g per m²)

Methods:

Because these measurements involve destructive sampling, no permanently marked plots were set up. All samples are taken 2-3 m parallel to the permanently marked species composition plots at each LTER site.

Individual flowering stem heights

A quasi-random walk is initiated adjacent to the permanent LTER transects during which 25 sampling points per transect (100/LTER treatment) are located at intervals of about 2 m. At each sampling point, the stem height for the nearest (no more than 1m from observer) flowering individual of each of the three species is measured to the nearest cm. Mean flowering stem height is calculated for each species at each site from the 100 values.

Density and weight of flowering stems

Along a transect parallel to the permanent LTER plant species composition transects but on the opposite side from where the PAB biomass collections for the year have occurred, six 0.25m² plots (50cm x 50cm) per transect (x4 transects = 24 per site) are sampled. Each plot is 3 m from the species composition marker and 10 paces from the next plot. Within each of these plots, the number of flowering stems of each species is counted and the stems are clipped at ground level, bagged by species, oven dried at 60°C, and weighed.

The density of flowering stems (No. per m²) and the mean biomass of flowering stem (g per m²) are calculated for each species.

PBG05

Title: Response of bird abundance to the Patch-Burn Grazing experiment at Konza Prairie (formerly designated CBS01_x)

Purpose: Patch-burn grazing of tallgrass prairie rangeland should provide a more diverse array of habitats for grassland bird species than traditional, uniformly-burned pastures. We are investigating variation in avian abundance, diversity, and nesting activity between patch-burned and uniformly-burned pastures at Konza Prairie Biological Station. Three watershed units (C3A, C3B, C3C) constitute “patches” that are alternately burned in a 3-year rotation within a single, fenced pasture (i.e., patch-burn grazing). Two additional watersheds are serving as controls: a grazed, annually/uniformly-burned watershed (C1A) and an ungrazed, annually/uniformly-burned watershed (1D). Eight, 300-m line transects were established in each watershed from which observers record the numbers of individuals per bird species and the perpendicular distance of individual birds from each transect. Three visits are made to each watershed between the last week in May through the end of June, where two “core” transects per watershed are sampled each visit. Six additional transects per watershed are sampled, but only once in a given year (two peripheral transects are sampled per watershed, per visit). The survey data will allow estimates of relative abundance, absolute density (determined from distance sampling), and species composition and diversity among the patch-burned and control watersheds. Vegetation structure is sampled along survey transects to characterize management-specific variation in physical attributes of avian habitat. Nest data are collected through systematic searches of nests throughout watersheds or from inclusion of nests found haphazardly by observers. Nest data are being analyzed for variation in daily nest survival and levels of brood parasitism of various species among the watershed units. The study design is providing research opportunities for students and faculty and will help guide range management decisions in tallgrass prairie.

Date data commenced: 05/23/2011

Date data terminated: ongoing

Location of Sampling Stations:

Three watershed units (C3A, C3B, C3C) constitute “patches” that are alternately burned in a 3-year rotation within a single, fenced pasture (i.e., patch-burn grazing). Two additional watersheds are serving as controls: a grazed, annually/uniformly-burned watershed (C1A) and an ungrazed, annually/uniformly-burned watershed (1D).

Frequency of Sampling:

Bird surveys require three visits each summer from late May through June. Sampling of vegetative structure is done on several visits through July.

Variable Measured:

Per each transect for bird surveys variables measured are: Watershed ID, Transect ID, Date, Start time, End time, Observer ID, Categorical sky conditions / precipitation, Wind speed (kph) and direction, Temperature (°C), Cardinal direction of end of transect where survey started.

Per each bird detected on each transect survey: Species, Sex, Visual (saw bird), Song (heard bird's song), Call (heard alarm call from bird), Fly only (bird flew overhead and never landed in survey area), Flush (bird flushed from habitat due to observer), Distance (perpendicular distance from transect line, m), Group size (numbers of individuals if occurred in a flock), Comments (sex ratio of group, found nest, etc.).

For each nest observers record: Nest identification number, Species constructing nest, Watershed ID, Way in which nest was found (R=Rope Drag, S=Saw Nest, FW=Flushed While Walking, FF=Followed Female), GPS coordinates of nest (easting and northing in UTM), Bearing and distance from nest marking flag to nest, Qualitative descriptions of vegetative characteristics surrounding nest (to aid in re-finding nests), Nest fate (fledged found, depredated, deserted, trampled, other)

During each nest visit to the nest observers record: Date, Time (24-hr), Observer initials, Whether a parent bird flushed from the nest, Number of host (bird species that built nest) eggs, Number of host young, Number of brown-headed cowbird eggs, Number of brown-headed cowbird young, Age score of young (0 = bare, eyes sealed; 1 = downy, eyes sealed; 2 = downy, eyes open; 3 = feathers starting to unsheathe; 4 = feathered), Parental behavior (0 = none detected, M1 = male seen near but not heard, F1 = female seen near but not heard, M2 = male near and chipping, F2 = female near and chipping, F3 = female near with food, M3 = male near with food),

If the nest appeared disturbed, If fecal sacs were present around the nest, If fledglings were spotted within the nest vicinity, Whether or not monitoring will be discontinued, Comments (misc.).

For vegetation sampling variables measured are: Date, Observer ID (of person making visual estimates), Watershed ID, Transect ID, Point ID (sample location along transect, 1-5), UTM_X (easting coordinate, UTM NAD 1983), UTM_Y (northing coordinate, UTM NAD 1983)

Frame Point ID (sample location at each point, 1-12), Percent grass (estimated percent horizontal coverage of grasses), Percent forb (estimated percent horizontal coverage of forbs), Percent shrub (estimated percent horizontal coverage of woody plants), Percent bare (estimated percent horizontal coverage of bare ground), Percent litter (estimated percent horizontal coverage of litter)

Litter depth (depth of litter in cm at lower left corner of frame), VOR Point (ID number of cardinal direction from which VOR reading taken), VOR (Visual Obstruction Reading; dm), Elevation (elevation of sampling point in m), Aspect (directional aspect of hill in degrees).

Methods:

Three watershed units (C3A, C3B, C3C) constitute "patches" that are alternately burned in a 3-year rotation within a single, fenced pasture (i.e., patch-burn grazing). Two

additional watersheds are serving as controls: a grazed, annually/uniformly-burned watershed (C1A) and an ungrazed, annually/uniformly-burned watershed (1D).

Surveys of adult birds. Eight, 300-m line transects were established in each watershed. Observers visit each watershed three times between the last week in May through the end of June, where two “core” transects per watershed are sampled upon each visit. Six additional transects per watershed are sampled, but only once in a given year (two peripheral transects are sampled per visit to each watershed). The transects were established using a stratified-random design, where each watershed was partitioned into two topographical blocks: an upland block (constituting the approximate upper half of the main watershed drainage) and a lowland block (constituting the approximate lower half of the main watershed drainage). Using ArcMap 10 (ArcGIS, ESRI, Inc.), twenty points (20-m minimum spacing) were randomly distributed within each watershed as single end-points for potential transects. The potential transects were fixed-width belt transects (sampling area 200 m x 300 m) and were only aligned in north-south or east-west orientations and directed toward approximate watershed interiors from end points. The twenty points were labeled with as many numbers (1-20) from which four points per watershed block were randomly selected and used as survey transects contingent upon the following conditions:

- The sampling area (200 m x 300 m) of all core transects must fall within the entirety of a watershed block and not overlap other core transects per watershed.
- 200 x 300-m peripheral transects can overlap with each other, core transects, and can cross into other blocks but must be contained within the entirety of a watershed.
- No ponds, roads, or woodlots must fall within any 200 x 300-m belt transect.
- If a complete set of eight transects could not be accommodated by the first 20m random points then additional rounds of 10 transect end-points were distributed and the selection routine repeated.

Bird surveys were conducted between 06:00 and 09:30. For each transect surveyed observers recorded: watershed ID, transect ID, date, start time (24-hr), end time (24-hr), observer ID, categorical sky conditions / precipitation, wind speed (kph) and direction, temperature (°C), and the cardinal direction from which the survey was started. On each transect observers recorded for each individual bird seen or heard perpendicular to the transect line and within the watershed boundary: species ID, perpendicular distance (m) from the transect (limited only by the watershed boundary, i.e.), gender, whether or not the bird was seen, vocalizations (song and/or call), whether the bird only flew over the surveyed watershed and never landed, the numbers of individuals if in a group, and other comments (e.g., sex ratio within groups). The survey data will allow estimates of relative abundance, absolute density (determined from distance sampling), and species composition/diversity among the patch-burned and control watersheds.

Nest surveys. Nests are searched for systematically among the watersheds or included in the data set if found haphazardly by observers. At a minimum observers record for each nest the ID of the species constructing the nest, nest contents (including clutch size of host and

number of eggs or young of the brown-headed cowbird, *Molothrus ater*), and nest location (at least to watershed ID, GPS coordinates in UTM NAD 83 also desired). Nests may be monitored every three to four days to estimate survival of eggs and young. During monitoring visits observers record nest contents, date and time of monitoring visit, observer initials, estimated age of young, parental behavior, disturbance to nest material, presence of fecal sacs or fledglings in the nest vicinity, and the estimated fate of offspring. Locations of nests that are monitored are marked with a small piece of blue, vinyl flagging tied onto vegetation 5 m from the nest. The compass bearing from this flag is recorded. Additionally, descriptions of nest site characteristics (plant species and structure, etc.) are recorded to aid in re-finding nests. Notation on how the nest was found (following parents, flushed while walking, etc.) is also recorded. Data from nest monitoring can be used in estimating daily survival rates and levels of brood parasitism by cowbirds.

Vegetation sampling. Vegetation structure was measured along each survey transect at five, equidistant points (spaced 75 m apart) between mid-July and mid-August. At each sampling occasion observers recorded: date (mm/dd/yyyy), observer initials (of person doing visual estimates), watershed ID code, transect ID code, ID code for sampling point along transect (1-5), and easting and northing coordinates (UTM NAD 1983). At each sampling point, samples were taken at 0 m (frame abutting the point center), 2 m, and 4 m from the point center in each cardinal direction (location ID points 1-12). At each location, a 20 x 50-cm Daubenmire frame was used to estimate horizontal coverage of vegetative / structural functional groups (grass, forb, bare, litter). Each cover type was scored using one of six cover classes (0-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%). Litter depth (cm) was measured in the lower left corner of the frame (relative to the view of the observer). Vertical visual obstruction of vegetation was measured at the center of the sampling point (the five points along the transect) from a distance of 4 m in each of the four cardinal directions. Elevation was estimated using a Garmin GPS. Hill aspect was estimated at each point to the cardinal directions or their 45° midpoints (e.g., “N” or “NE”).

Form of Data Output:

Data are entered to Microsoft Excel spreadsheets.

PBG06

Title: Cattle grazing and cattle performance in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated CCC01_x)

Purpose: Long-term monitoring of dynamics of cattle grazing on each of two sets of three pastures burned each year on a rotating basis and cattle performance including cow weight gain, body condition, reproductive performance and calf weight gains.

Date data commenced: 04/01/2010

Date data terminated: ongoing

Location of Sampling Stations:

The study is comprised of two units on Konza Prairie that line the west side of Kansas Highway 177. The south unit (watersheds C3A, C3B, and C3C) consists of 452 acres and is stocked with 56 cow calf pairs, with 27 pairs on the smaller adjacent control plot (watershed C1A). The replicating north unit (watersheds C3SA, C3SB and C3SC) is stocked with a comparable 103 pairs on 829 acres with 19 pairs on the adjacent control plot (watershed C1SB).

Each unit has been divided into three sections. Cattle will be allowed to roam the entire unit. But only one-third of the unit will be burned each year on a rotating basis. See “Burn History” on the Konza LTER website.

Frequency of Sampling:

Cattle will be weighed and assigned a body condition score on or about May 1, July 15, and October 1 of each grazing season. Reproductive success will be assessed on or about July 15 and October 1 of each grazing season.

Variable Measured:

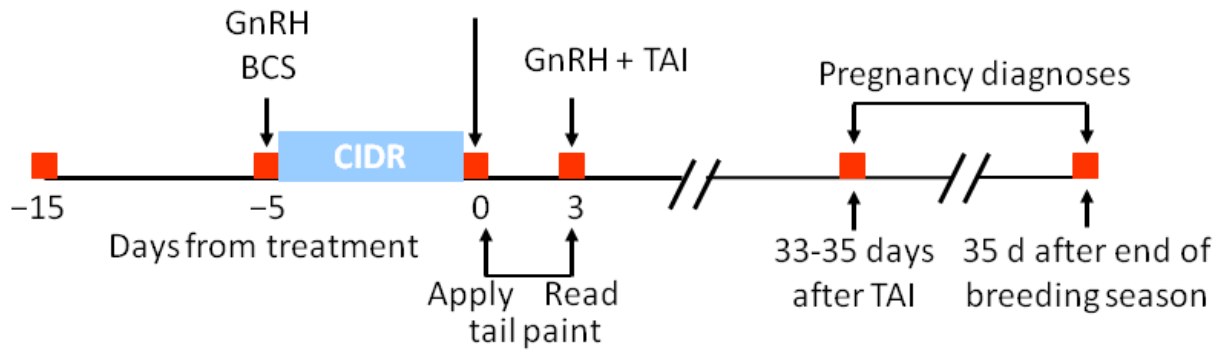
Weights and condition of cows and calves. Reproductive performance of cows.

Methods:

Cow body-weight (BW) and body-condition-score (BCS) measurements are obtained on the day individual cows calve, at the time of fixed-time artificial insemination (AI), and at weaning. At each time point, cow BCS is assigned (1 to 9 scale; 1 = emaciated, 9 = morbidly obese) by 3 trained observers that are blinded to treatment; the average of 3 scores is recorded. Calf BW is recorded at birth, at the time of fixed-time AI, and at weaning.

Ovulation is synchronized using a 5-day CO-Synch + controlled-intervaginal-drug-release (CIDR) protocol (Figure 1) and cows are inseminated 72 hours after CIDR removal. Cows are exposed to fertile bulls for natural-service breeding beginning 10 days after fixed-time AI for 50 days. Conception to fixed-time AI is determined via ultrasound 33 to 35 days after AI and final pregnancy rate was determined via rectal palpation approximately 120 days after AI. Subsequent calving dates are recorded in order to establish distribution over a 60-day calving season.

Figure 1. Standardized estrus-synchronization and artificial insemination protocol.



Summary of All Changes:

2010: South Unit initiated along with adjacent control plot (watersheds C3A, C3B C3C and C1A).

Spring 2011: North Unit initiated (watersheds C3SA, C3SB, C3SC and C1SB).

PBG07

Title: Grasshopper species abundances in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated CRG02_x)

Purpose: To estimate relative abundances of grasshopper species in the patch-burn grazing experiment.

Date data commenced: 05/08/2011

Date data terminated: ongoing

Location of Sampling Stations:

Species specific grasshopper abundances are determined on upland topographic locations. C3A, C3B, C3C, C1A, C3SA, C3SB, C3SC, C1B along the plant sampling transect at each site over 4 sites per watershed.

Frequency of Sampling:

Grasshopper abundances are sampled once in late summer (August-September), with each site sample twice in a season a week apart.

Variable Measured:

Number of individuals (categorized by instar) for individual grasshopper species.

Methods:

Three watershed units (C3A, C3B, C3C) constitute “patches” that are alternately burned in a 3-year rotation within a single, fenced pasture (i.e., patch-burn grazing). Two additional watersheds are serving as controls: a grazed, annually/uniformly-burned watershed (C1A) and an ungrazed, annually/uniformly-burned watershed (1D).

Grasshopper sampling is done by standardized sweeping with canvas beating nets 38 cm in diameter. A sample of 250 sweeps (ten sets of 25 sweeps each) is taken at each site (4 independent sites per watershed) on each occasion. A sweep is taken at each step by traversing an arc of 180° with the net through the top layer of vegetation. After 25 such sweeps, the contents of the net are emptied into individual plastic bags. Air is squeezed out and samples are kept on ice until they can be later frozen that same day. Samples are sorted and identified to species and instar at a later date. Samples are taken between 1000 and 1500 hours on clear, calm warm days: cloud cover is less than 50%, wind speed less than 24km/hr (15 mph), and ambient air temperature should be 25-40°C.

Sampling is replicated at each site a week apart. Sweep sampling methods follow those used for grasshopper sampling in the bison grazed watersheds. Sweeping effectiveness varies with site and season on Konza Prairie (e.g. sweeping is less effective on unburned prairie than on burned prairie). However, sweeping provides good estimates of relative abundances of individual species present at any one place and time on both burned and unburned prairie. For more information, consult: Evans, E. W., R. A. Rogers, and D. J. Opfermann. 1983. Sampling grasshoppers (Orthoptera: Acrididae) on burned and

unburned tall grass prairie: night trapping vs. sweeping. Environmental Entomology 12:1449-1454. Rarefaction calibrations determined that the cumulative species abundance curve reached an asymptote between 175-250 sweeps.

PBG08

Title: Grasshopper density survey in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated CPR011x)

Purpose: To estimate grasshopper densities in the patch-burn grazing experiment.

Date data commenced: 08/01/2010

Date data terminated: ongoing

Location of Sampling Stations:

Grasshopper density is determined on upland topographic location. C3A, C3B, C3C, C1A, C3SA, C3SB, C3SC, C1B

Frequency of Sampling:

Grasshopper densities are sampled once in late summer (August-September).

Variable Measured: Grasshopper density

Methods:

Three watershed units (C3A, C3B, C3C) constitute “patches” that are alternately burned in a 3-year rotation within a single, fenced pasture (i.e., patch-burn grazing). Two additional watersheds are serving as controls: a grazed, annually/uniformly-burned watershed (C1A) and an ungrazed, annually/uniformly-burned watershed (1D).

At each site, grasshopper densities are sampled using the ring count method (Onsager 1977*), a standard technique for estimating grasshopper densities. Twenty quadrats (0.1 m²) are placed along four transects at each site (80 quadrats per site) and left in place for a minimum of 5 hours. Then, grasshopper densities are counted by slowly approaching each ring and counting the number of grasshoppers within each ring.

*Onsager J.A. (1977). Comparison of 5 methods for estimating density of rangeland grasshoppers (Orthoptera: Acrididae). *Journal of Economic Entomology*. 70:187-190.

PBG09

Title: Responses of small mammals in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated CSM011x)

Purpose: Examine the effects of patch-burn grazing on small mammal biodiversity and population dynamics

Date data commenced: 11/06/2011

Date data terminated: ongoing

Field Methods:

We established two trap grids for sampling small mammal community and population dynamics in each of the three PBG patches (C3A-C) and two controls (C1A, K4A), for a total of ten grids. Grid locations were selected at random, but subject to two constraints. To maintain independence among trap grids, grids were separated by at least 200 m, which corresponds to twice the length of the longest published home range axis for deer mice (*Peromyscus maniculatus*), the most abundant species of small mammal encountered in native prairie. Trap grids were also located at least 100 m from unit boundaries to avoid potential boundary effects, and >50 m from permanent or regularly flowing water to avoid flooding of traps during runoff from thunderstorms (Konza LTER datasets: GIS210 and GIS211).

Each trap grid was a five-by-five square design with 25 stations and 20 m spacing between adjacent trap stations for a total area of 0.64 ha. Two extra-large Sherman live traps were set at each trap station for a total of 50 traps per grid (Model LNG 12, H.B. Sherman Trap Company, Tallahassee, FL, USA). Traps were baited with a mixture of peanut butter and rolled oats, and each trap was provisioned with polyester fiberfill to keep animals warm during October to May. To reduce heat stress to diurnal mammals, wooden A-frame structures (hereafter, trap shelters) were placed over traps for shading. Trap shelters were left in place all year for weathering and to minimize potential neophobic responses of small mammals to trap stations.

During our 3.5-year study from June 2011 to December 2014, small mammals were trapped for three consecutive nights each month at ten trapping grids. We marked small mammals with passive integrated transponders (PIT tags hereafter; Model AB10320, FDX-B 7 x 1.35 mm, Loligo Systems, Tjele, Denmark; or “Skinny” FDX-B 8 x 1.4 mm, Oregon RFID, Portland, Oregon USA), and read tags with a handheld reader (Model APR 350 FDX/HDX Reader, Agrident, Manassas, VA, USA; or DataTracer FDX/HDX Reader, Oregon RFID, Portland, Oregon, USA). PIT tags were injected subcutaneously under loose skin at the nape, and massaged away from the insertion site to ensure tag retention. To obtain an estimate of PIT tag retention, 28% of the rodents were tagged with numbered monel ear tags (model 1005-1, National Band and Tag Company, Newport, Kentucky, USA). PIT tag losses were rare (<1%). All procedures were approved by the Kansas State University Institutional Animal Care and Use Committee

(protocols 3034 and 3443), and conducted under state wildlife permits from Kansas Department of Wildlife, Parks, and Tourism.

PBG10

Title: Soil physical and chemical characteristics in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated NSC011x)

Purpose: To measure bulk density, soil organic matter, pH, cation exchange capacity, soil cations (Ca⁺⁺, Mg⁺⁺, Na⁺), phosphorous and total Kjeldahl nitrogen of soils at the vegetation transects in C3SA, C3SB, C3SC, C1SB, C3A, C3B, C3C, and C1A.

Date data commenced: 10/06/2010

Date data terminated: ongoing

Location of Sampling Stations: Soils are sampled along the vegetation transects.

Frequency of Sampling:

Sampling was initiated on 10/6/2010. Sites are now scheduled to be sampled in the fall seasons of every 5th year.

Variable Measured:

Bulk density, pH, cation exchange capacity, concentrations of Ca⁺⁺, Mg⁺⁺, and Na⁺, extractable phosphorous, and total Kjeldahl nitrogen, K, Zn, Cu, Fe, Mn, NH₄⁺-N, and NO₃⁻-N.

Methods:

An Oakfield Soil Sampler, with a coring diameter of 3/4" (19.05 mm) is used to obtain soil. Litter is scraped off of the surface prior to inserting the tube. Soils are sampled to a depth of 5 cm at all upland sites. A composite sample is obtained by taking ten 5 cm cores along each of the vegetation transects and mixing these together in plastic zip-closed bags.

All samples were stored at 5-10°C until they could be processed. The samples were sieved through a #5 U.S.A. Standard Testing sieve (4 mm opening). All visible rocks and large root fragments are subsequently removed from the sieved soil. Sorting takes approximately 20 minutes for each composite sample. Sieved soil is returned to the plastic sampling bag and submitted to the K.S.U. Soils Testing Laboratory for chemical analyses. Upon completion of analysis, any remaining soil is returned to KSU Biology for archival storage.

Bulk density data are obtained from the individual cores placed in soil tins. These are air-dried and weighed, sieved (as above) and reweighed, then dried at 105°C and weighed a final time. No chemical analyses are performed on these samples.

Locations of Archived Soil Samples: Bushnell Annex 121

Procedures for Chemical:

KSU Soils Testing Laboratory used their standard test procedures. Details about their various procedures may be found through their website:

www.agronomy.ksu.edu/soiltesting/

PBG11

Title: Stream Water Chemistry for the Shane Creek drainage basin in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated NWC011x)

Purpose: To determine the effects of fire frequency on both baseflow and stormflow concentrations of nitrogen and phosphorus.

Date data commenced: 06/01/2010

Date data terminated: ongoing

Location of Sampling Stations: Shane Creek (T-9)

Frequency of Sampling:

Base flow samples are collected 3 times per week in mornings. If the base flow collection time corresponds to a storm flow event, they are classified as such.

Variable Measured:

NO₃ -N + NO₂ -N, NH₄ -N, total-N, SRP (or soluble reactive phosphate), total-P, and dissolved organic carbon.

Field Methods:

Samples (250 mL) from mid-stream are collected 2-3 times per week. Date, time of day (CST), stream temperature (c) and stream height.

Sub-samples (three 20mL vials) are taken upon returning to the lab. Samples are immediately frozen.

Laboratory Methods:

One vial is analyzed for inorganic nitrogen (N) and phosphorous (P). A second vial is run for dissolved organic carbon (DOC). The third vial is run for TN or total nitrogen, and TP or total phosphorous. At the completion of all analyses the vial with maximum volume is stored in the freezer as an archived sample for 10 years from date of collection.

Nitrogen and phosphorus nutrients are performed by colorimetric determination on a flow solution analyzer. Dissolved organic carbon is measured by high temperature combustion. Data is compiled annually, checked by the RA, and archived by the IM.

PBG12

Title: Konza Stream Geomorphology in the Patch-Burn Grazing experiment at Konza Prairie (formerly designated ASG011x)

Purpose: Cattle grazing is a common land management practice throughout the United States and very prevalent in native remnants of Great Plains prairie grasslands. Cattle have a direct influence on stream morphology due to their summer grazing habits. Cattle graze near riparian vegetation due to water and food availability. Experimental grazing treatments at the Konza Prairie LTER represent an excellent opportunity to study stream channel response to grazing impacts. Seventeen watersheds were evaluated in a paired watershed geomorphological assessment, with 4 grazed by native bison, 5 grazed by cattle, and 8 ungrazed watersheds, to enable cross-watershed comparative analysis to quantify how stream morphology vary between ungrazed, cattle-grazed and bison-grazed watersheds.

Date data commenced: 06/01/2010

Date data terminated: ongoing

Frequency of Sampling: Annually

Variable Measured: Channel geometry (width (m), depth (cm), width:depth (unitless))

Methods:

Channel geometry is measured by establishing ten permanently monumented cross sections and topographically surveying with a surveyor's level and leveling rod at 15.24 cm (6 inch) spatial resolution. Active channel width is defined as the distance from the top of the lower bank to the equivalent elevation on the adjacent bank. Top of bank is identified by a break in slope along with sediment deposits and changes to perennial vegetation. The depth value is calculated by averaging the elevations along the width with the lower bank top used as a reference elevation of 0.

PCN01

Title: Plant and soil carbon and nitrogen pool data from the Belowground Plot Experiment at Konza Prairie

Purpose: To assess legacies of previous nitrogen-fertilization in plant and soil carbon and nitrogen pools.

Date data commenced: 03/01/2021

Date data terminated: 09/31/2021

Location of Sampling Stations: Belowground Plot Experiment.

Variable Measured:

Litter biomass, accumulated plant biomass, total carbon and nitrogen.

Frequency of sampling:

Combustible aboveground litter were collected approx. 1 month prior to the prescribed fire in 2021. Shoots, roots, litter, and soil for carbon and nitrogen stock were collected in September 2021. Shoots and litter are aboveground plant biomass collected for PBB01.

Field Methods:

Field and lab methods are identical to those for PBB01 for aboveground plant biomass collection. Soil and roots were collected from four 5 cm diameter, 15 cm depth cores from each plot, or 1 from each sub-plot. Roots were extracted as soil was sieved through 4 mm. Roots from each core were kept separately, while soil was combined as plot composites.

Quality assurance:

Total carbon and nitrogen were quantified using thermal conductivity, Standard quality control. instrumentation: Litter biomass, root, and soil: FlashEA 1112 NC Analyzer, Accumulated plant biomass: LECO TruSpec CN Combustion Analyzer.

PEW01

Title: Plant species composition and edaphic properties in wallow and non-wallow plots at Konza Prairie

Purpose: To determine differences in plant communities and edaphic properties of fenced and non-fenced wallows and adjacent prairie, as well as cattle-grazed plots in two fire frequencies (annual and 3-4 year), and to track the hydroperiods of wallows across Konza Prairie.

Date data commenced: 06/01/2021

Date data terminated: 8/31/2024

Frequency of Sampling: Wallow Plant Composition: Twice per year (June and August) from 2021-2024
Wallow Soil Physiochemical Data: once per year (September) from 2021-2023
Wallow Hydrological Data: at least once per week June-September 2022, 2023

Location of Sampling Stations: N1B, N4D, C1A, C3C in mid-elevation flat benches

Variable Measured: Canopy covers of all vascular plant species in each subplot are estimated; soil physiochemical properties; percent cover of water in wallows.

Methods:

Field Methods

Wallow Plant Composition data: In each watershed, 12 circular plots of each type (fenced wallow, fenced control, unfenced wallow, unfenced control, and cattle control) with 8 subplots each were established in 2020 (all bison-plots) and 2022 (all cattle-plots).

Wallowalls are all approximately 10 sq m in area and all controls are 15 sq m. The subplots are arranged on 4 equidistant transects radiating from the center of the plot with four subplots within the depression of the wallow (or the 0.75 m from center of control plots) and four subplots straddling the edge of the wallow (or 1.75 m from the center of control plots). Within each subplot canopy cover of all vascular plant species and bare ground was estimated (Note: bare ground was estimated at non-live plant cover which included litter) using modified Daubenmire scale (1: 0-1%, 2: 1-5%, 3: 5-25%, 4: 25-50%, 5: 50-75%, 6: 75-95%, 7: 95-100%).

Wallow Soil Physiochemical Data: In each watershed, 12 circular plots of each type (fenced wallow, fenced control, unfenced wallow, unfenced control, and cattle control) with 8 subplots each were established in 2020 (all bison-plots) and 2022 (all cattle-plots). Wallowalls are all approximately 10 sq m in area and all controls are 15 sq m. The subplots are arranged on 4 equidistant transects radiating from the center of the plot with four subplots within the depression of the wallow (or the 0.75 m from center of control plots)

and four subplots straddling the edge of the wallow (or 1.75 m from the center of control plots). Approximately 10 cm outside of each of the inner subplots (between inner and outer subplots), a 10 cm deep soil core (2 cm diameter) was taken. All four cores were combined as one homogenized sample per plot. Soil samples were sieved (4 mm mesh) to remove large roots and rocks and refrigerated at 4 C to minimize microbial transformations prior to analysis. Samples were sent to the Kansas State University Soil Testing Laboratory where they were analyzed for nutrient content (e.g., total nitrogen, potassium, phosphorus), cation concentrations (e.g., sodium, magnesium), pH, and soil texture. More detailed soil methodology can be found on the KState Soil Testing Lab website.

Wallow Hydrological Data: From June to September in 2022 and 2023, we monitored 48 wallows approximately every other day and estimated the percent cover of standing water in each wallow until there was no more standing water. Then, if no rainfall occurred, wallows were checked weekly or bi-weekly. If rainfall occurred, monitoring resumed as quickly as possible and continued every other day until wallows re-dried.

Form of Data Output: PEW011 contains the cover class value for each species detected in the plot. For species that are sampled on both census dates, the highest cover class of each plot is used for analyses. Percentage cover for each species is computed by averaging the mid-points of the cover classes; PEW012 contains the value of each soil physiochemical property measured for each plot for each year; PEW013 contains the estimate of percent cover of water in a wallow on the date checked.

Quality Assurance: All data were manually input twice and checked for errors against each other.

Summary of All Changes: Cattle plots were added in spring 2022. Soil texture (clay, silt, sand) was excluded in 2023 and Total phosphorus and Cl⁻ added instead.

PSC01

Title: Exploring effects on stream ecosystems properties by two size classes of prairie stream cyprinids

Purpose: Losses in freshwater fish diversity might produce a loss in important ecological services provided by fishes in particular habitats. An important gap in our understanding of ecosystem services by fishes is the influence of individuals from different size classes, which is predicted based on known ontogenetic shifts in habitat and diet. I used twenty experimental stream mesocosms located on Konza Prairie Biological Station (KPBS), KS, USA to assess the influence of fish size on ecosystem properties. Mesocosms included two macrohabitats: one riffle upstream from one pool filled with consistent pebble and gravel substrate. There were four experimental and one control treatment, each replicated four times ($N = 20$). I used two size classes of Central Stonerollers (*Campostoma anomalum*) and Southern Redbelly Dace (*Chrosomus erythrogaster*). Five ecosystem properties were assessed: algal filament length (cm), benthic chlorophyll a ($\mu\text{g}/\text{cm}^2$), benthic organic matter (g/m^2), macroinvertebrate biomass (g/m^2), and stream metabolism ($\text{g O}_2/\text{m}^2/\text{day}^1$). Size structure of fish populations affected some, but not all, ecosystem properties and these effects were dependent upon species identity. Size structure of both species had effects on algal filament lengths where stonerollers of both size classes reduced algal filaments, but only small redbelly dace kept filaments short. A better understanding of the relationship between these prairie stream minnows and their small stream habitats could be useful to both predict changes in stream properties if species are lost or size structure shifts, and to redbelly dace populations, a Species In Need of Conservation.

Date data commenced: 10/01/2012

Date data terminated: 10/31/2012

Methods:

Mesocosm design and preparation: I used twenty experimental stream mesocosms located on Konza Prairie Biological Station (KPBS), KS, USA (also described in Matthews et al., 2006; Martin et al., 2016) to test how fish size influence their influence on stream ecosystems. The experiment ran for 30 days (1 to 31 October, 2012). Mesocosms included two macrohabitats: one riffle (area = 0.8 m^2) upstream from one pool (area = 2.5 m^2) filled with consistent pebble and gravel substrate (mean area 40 cm^2). Flow was generated by a trolling motor pulling water through a 15.2 cm diameter solid black corrugated plastic drainage pipe connecting the pool to the riffle. Prior to the start of the experiment, streams were drained of any incidental water (e.g., rainwater) and left dry for four full weeks. Next, I scoured and washed the substrate and inside of each mesocosm with a pressure washer, after which streams were drained and left to dry for several days. Finally, mesocosms were filled with spring water using an underground PVC pipe system from the same springs that naturally fill nearby Kings Creek. Mesocosms take 2-3 days to fill completely, and once all mesocosms were filled, trolling motors were turned on and mesh baskets with open tops were buried in the substrate.

Mesocosm homogenization: Allowing mesocosms to be fully dry for long periods of time and then pressure washing the substrate and walls promoted homogeneity among units. Furthermore, prior to beginning the experiment, flow and depth were measured using a Marsh-McBirney flowmeter and meter stick along three transects in each riffle ($n = 9$) and at along four transects in each pool ($n = 19$) within each reach for roughly 10 measurements per m^2 for each habitat, and a mean flow and depth were calculated for each macrohabitat. Based on an analysis of variance (ANOVA), there was no evidence for significant differences among habitat types across mesocosms for flow (i.e. all riffles were similar to each other and all pools were similar to each other; $F_{6,42} = 0.97$, $P = 0.46$) or depth ($F_{6,42} = 0.18$, $P = 0.98$).

Experimental design: There were four experimental treatments and one control treatment, each replicated four times ($N = 20$ mesocosms). Experimental treatments were additions of fish based the two most abundant herbivorous species (stonerollers and redbelly dace) in Kings Creek, the stream located on the KPBS, and one control treatment. All fish ($N_{total} = 2,336$) were collected from nearby Kings Creek and stocked on 28 September, 2012 and given two days to acclimate. Each species was represented by two size classes, creating four fish treatments: small stonerollers (mean total length (TL) = $56 \text{ mm} \pm 3.9 \text{ mm}$ standard deviation (SD), mean weight (W) = $0.76 \text{ g} \pm 0.17 \text{ g}$), large stonerollers (TL = $81 \text{ mm} \pm 2.7 \text{ mm}$, W = $2.35 \text{ g} \pm 0.24 \text{ g}$), small redbelly dace (TL = $31 \text{ mm} \pm 1.6 \text{ mm}$, W = $0.13 \text{ g} \pm 0.01 \text{ g}$), and large redbelly dace (TL = $53 \text{ mm} \pm 1.1 \text{ mm}$, W = $0.65 \text{ g} \pm 0.09 \text{ g}$). Weights of fishes were calculated from standard length (SL) values using the standard length-weight equation $W = aL^b$ where $a = 0.0037$ and $b = 3.08$ (K. Gido, unpublished data). Cutoff lengths for juveniles versus adults (stonerollers = 65 mm, redbelly dace = 55 mm) were based on published accounts of length at maturity for both species (Hubbs and Cooper, 1936; Settles and Hoyt, 1978; Edwards, 1997; Martin et al., 2013). All fish were measured (total length) prior to stocking mesocosms. Fish biomass was $15 (\pm 3) \text{ g}/m^2$, $16 (\pm 1.3)$,) for juvenile and adult stonerollers, respectively and $29 (\pm 12.4)$ and $24 (\pm 1.7)$ for juvenile and adult redbelly dace, respectively. The total biomass of these fishes varies significantly, and our biomass reflects the highest end of this natural variation (Martin et al. 2016). Fish deaths and TL of dead were recorded and replaced with similar sized fish during the acclimation period. The fifth treatment served as a control with no fish added to the streams.

Response variables: Five variables were selected as they comprise the basic ecosystem functioning and food web dynamics in streams and are based on extensive work in natural and experimental streams (algal filament length [cm], benthic chlorophyll a [$\mu\text{g}/\text{cm}^2$], benthic organic matter [g/m^2], macroinvertebrate biomass [g/m^2], and stream metabolism [$\text{g O}_2/m^2/day$], Evans-White et al., 2001; Bertrand and Gido, 2007; Murdock et al., 2011; Martin et al., 2016). These ecosystem properties were measured in pools at the end of the experiment. To quantify structural properties of the periphyton, algal filament lengths (AFL) were measured in centimeters using a meter stick along four transects in each pool ($n = 19$) within each mesocosm for 10 measurements per m^2 for each pool. Filament lengths were measured as the length of the longest filament attached to a pebble that occurred on the transect point. To assess benthic chlorophyll a, macroinvertebrates, and organic matter, the three 10 cm^2 mesh baskets were filled with

pebbles and buried in each pool prior to the start of the experiment were collected. One basket was removed at the end of the experiment for chlorophyll a analysis: three pebbles were collected from the basket, chlorophyll a was extracted where the concentration of chlorophyll a was corrected for cross-sectional area of pebbles (see Sartory and Grobbelaar, 1984; Bertrand and Gido, 2007 for detailed methods on chlorophyll a extraction). The second basket was removed to quantify coarse and fine benthic organic matter (CBOM and FBOM, respectively) analysis. The basket was placed into 8 L of water from the mesocosm and the substrate vigorously stirred by hand. Next, a 500 mL subsample of the slurry was collected. The subsample was preserved using 10% formalin, taken to the laboratory, filtered through two mesh sizes (coarse [1 mm mesh filter] and fine [GF/F 47 mm microfiber filter]), dried at 60 °C, weighed, ashed at 450 °C, and re-weighed to determine ash-free dry mass (AFDM) (Wallace et al., 2007). AFDM was extrapolated using the surface area of the basket. Macroinvertebrates were sampled by a similar procedure to organic matter, where the third basket was placed in 8 L of water from the mesocosm and vigorously stirred by hand to release attached macroinvertebrates. Here, the resulting slurry was elutriated to separate inorganic substrate from organic matter and poured through a sieve (250 µm mesh) to capture macroinvertebrates. Samples were preserved in 10% formalin and taken to the laboratory where invertebrates were counted and identified to order or family (Thorp and Covich, 2001; Merritt et al., 2008). Chironomids were initially classified as Tanypodinae or non-Tanypodinae; however, because Tanypodinae chironomids constituted < 1% of sample biomass, all chironomids were combined into a single group. Lengths of macroinvertebrates were estimated to calculate biomass for each macrohabitat using standard length-mass relationships (Benke, 1984). Macroinvertebrate biomass was calculated by dividing the total biomass of the sample by the surface area of the basket. Finally, whole stream metabolism (gross primary production [GPP]) was measured based on fluctuations in dissolved oxygen content ($\text{g O}_2 \text{ m}^{-2} \text{ day}^{-1}$) of the water measured every 60 min from 05:00 to 17:00 using a YSI550A handheld dissolved oxygen sensor. The sensor was deployed in the same location in each mesocosm pool near the observation window. These rates were corrected for variation in temperature, dissolved oxygen saturation, light, atmospheric pressure, and stream mesocosm morphology based on the single-station modeling technique outlined in Riley and Dodds (2013) and Dodds et al. (2013). In short, this method uses a standard equation (Marzolf et al., 1994) to predict dissolved oxygen concentration. Modeled dissolved oxygen (see Martin et al., 2016 for model example) is compared to observed dissolved oxygen using the Solver function in Microsoft Excel (version 2007; Microsoft Corporation, Redmond), which uses a Newton search method to minimize the sum of squares of error between modeled and observed values by changing the basic rates of GPP, ER, and gas transfer coefficient (k).

Data analysis: Differences among treatments for each of the five response variables was tested by performing single-factor Kruskal-Wallis (K-W) test to assess treatment effects ($\alpha = 0.05$) comparing juvenile stonerollers, adult stonerollers, and the control. Separate single-factor K-W compared juvenile redbelly dace, adult redbelly dace, and control. If the K-W test was significant, a Dunn's post-hoc test was performed. All statistical

analyses were run using R 4.2.2 (R Core Team, 2022) with library FSA (Ogle et al., 2022).

RCS01

Title: Recovery and relative influence of root, microbial, and structure properties of soil on physically sequestered carbon stocks in restored grassland at Konza Prairie

Purpose: To quantify recovery of ecosystem properties with restoration and develop a multivariate hypothesis of C sequestration from physical protection using structural equation modeling.

Date data commenced: 2013

Date data terminated: ongoing

Location of Sampling Stations: A restoration chronosequence in the headquarters area was sampled; this consisted of an agricultural field next to the “Sequential Restoration Plots”, the first two sequences of the “Sequential Restoration Plots”, the “Konza Dominance Experiment”, the restoration next to the nature trail, the Gelroth property, and “Headquarters Prairie B” (native prairie reference).

Frequency of Sampling: One sampling in late August 2013.

Variable Measured: Soil aggregates, PLFA profiles, microbial biomass C, root biomass and quality.

Field Methods:

Four plots were delineated in each field representing a different aged restoration. Two intact cores (5.5 cm diameter, 10 cm deep) were collected per sampling plot.

Laboratory Methods:

Belowground biomass was handpicked from two composited intact cores (5.5 cm diameter to a depth of 10 cm) that were broken along planes of natural weakness until passing through an 8 mm sieve. Microbial biomass was determined by the fumigation-extraction technique. Phospholipid fatty acids (PLFA) were extracted from subsamples of the intact soil cores that were frozen after sampling. Additional soil subsamples were slacked and wet sieved to separate aggregate fractions (large macroaggregates, small macroaggregates, microaggregates, and free silt/clay) by size. Intra-aggregate fraction [intra-aggregate coarse particulate organic matter (CPOM), intra-aggregate microaggregates, and Intra-aggregate silt/clay] were isolated by breaking aggregates with ball bearings on a shaker and wet sieving. Aggregate and intra-aggregate fractions were used if there was a 95% recovery. Carbon content was determined by flash combustion of finely ground subsamples of soil fractions. The C:N ratio of intra-aggregate CPOM was also determined by flash combustion of finely ground subsample of this fraction. Mean weight diameter was calculated from mass of aggregate fractions. Bulk density was determined from a core method with a 5.5 cm diameter core taken to a depth of 10 cm. Total C stock was determined by adding aggregate fractions.

Form of Data Output: Linear and non-linear regressions and a structural equation model were generated.

Quality Assurance: Data entry was checked for correctness.

Instrumentation: Flash 2000 CNHSO Elemental Analyzer (Thermo Scientific, Waltham, MA) solid phase column (0.50 g Si, Supelco, Inc., Bellefonte, PA), Shimadzu GC-2010 gas chromatograph with a flame ionization detector (Shimadzu Corp., Kyoto, Japan), and Omegawax 320 column: 30 m by 0.25 mm i.d., 0.25-mm film (polyethylene glycol phase) (Supelco, Bellefonte, PA).

RFP01

Title: Properties of large hillslope blocks and cliff faces along the cottonwood limestone near the Konza Prairie Nature Trail

Purpose: To quantify how the properties of large rock blocks (boulders) influence their movement and transport downslope on low gradient soil mantled hillslopes.

Date data commenced: 06/01/2019

Date data terminated: 08/31/2021

Location: We studied a prominent limestone bench formed from the Cottonwood Limestone and hillslopes below the cliff. This occurs along the nature trail portion of Konza Prairie (Nature Trail and K1A). The studied section of cliff mainly faces south and east, with some sections facing north. The study cliff formed by the Cottonwood Limestone and the hillslope under it are covered by mostly grassland and some forest. Forested sections are occupied by a combination of trees and dense woody underbrush that grow on top of and in the fractures of the cliff face and around the blocks on the hillslope under it.

Frequency of measurement: Properties of the Cottonwood Limestone cliff and blocks on the hillslopes under it were recorded every ~25 m for a 2 km distance along the cliff, excluding locations near trails.

Variables measured: Hillslope Block – size, shape, surface weathering, block emedding, block stability, block dip. Cliff Surface – fracture spacing, surface weather, height.

Methods:

Block properties were measured for all blocks in a 30 m long, 2 m wide transect straight down the slope from the cliff face formed by the Cottonwood Limestone. Block measurements were performed by hand and visual assessment. A set of four cliff measurements were collected for each location separated by 2 m to capture local variability. Block and cliff measurements were performed by hand and visual assessment. Minimum block size observed was set at 64 mm (corresponding to a 0.004 m² surface area). This minimum represents the cut off between pebble and cobble sized rock fragments and represents the smallest grainsize that can be easily observed in the grassy study location. Distances between all blocks and the overlying cliff were measured along the transect line from the center of the slop block. Block size was recorded as two measurements: the length of the longest and intermediate axes of the block. Each axis was perpendicular to the other. Weathering state was assessed visually as the percentage of the visible block surface that was occupied by surface pitting or spalling. Block dip in the downhill direction was measured in degrees using a digital inclinometer placed at the center of the block. Additionally, qualitative observations of stability, burial, and embedding were recorded to deduce transport processes. Block stability was recorded as stable or unstable depending on if movement or rotation resulted from the force of a

human foot pushing the block. Burial condition was based on how embedded a block was in soil. The perimeter of embedded blocks was probed with either a soil knife or rock hammer to estimate the depth at which the bottom of the block occurred and in extension how much of the block was buried below the soil surface. If at least 50% of the block's short axis was embedded, then a block was described as buried in soil. Blocks that were less than 50% embedded were recorded as unburied on all sides, whereas blocks only buried on the upslope or downslope faces were recorded as such. Blocks were categorized by shape into classes of cubic and tile-shaped. A total of 30 slope block survey transects were performed, resulting in a total of 842 block observations.

RIV01

Title: Stream water isotopes in wooded riparian areas and areas where canopy had been cut at Konza Prairie

Abstract: The stream water samples are the same as collected for the NWC01 dataset. Water samples are frozen (-3C) in sealed polyvinyl bottles until time of processing. These water samples are thawed, subsampled at 1 mL, and analyzed for delta18O and delta2H using a Picarro L2130-i isotopic water analyzer. Samples are corrected using in-house standards calibrated to the international standard, V-SMOW. The long-term precision for delta18O is 0.1 permil and for delta2H is 1 permil.

Date data commenced: 01/01/2010

Date data terminated: 12/31/2020

Methods:

The stream water samples are the same as collected for the NWC01 dataset. Please check NWC01 for more details.

RIV02

Title: Plant transect data for the N2B experiment at Konza Prairie

Purpose: To determine if plant communities are able to “bounce back” after repeated woody plant removal, returning to plant community more similar to tallgrass prairie without woody plant encroachment.

Date data commenced: 06/01/2010

Date data terminated: 10/01/2020

Methods:

Measurements were taken in three “treatments”: the non-woody riparian zone, the woody riparian zone without additional seeds, and the woody riparian zone with additional seeds. In each treatment, there are four plots, each of which were 10 m parallel along with 3 m perpendicular to the stream channel. Each plot had four plant composition transects along which we sampled four one m² subplots along each transect. Vegetative cover of vascular plant species was determined using a modified Daubermire scale, with measurements taken in the spring and autumn in 2010, 2011, and 2020. When a species was present at both times, the maximum annual cover was used.

RIV03

Title: Channel morphology in streams in wooded riparian areas and areas before and after canopy cutting at Konza Prairie

Purpose: To test if woody removal in a riparian zone allowed the system to rebound to a grassland stream state.

Date data commenced: 01/01/2010

Date data terminated: 12/31/2019

Methods:

Channel morphology transects were surveyed in 2011 and resurveyed in 2019 in watersheds N2B (7 transects) and N1B (8 transects) as in Grudzinski and Daniels (2018). Briefly, we established permanent cross-sections in each watershed, spaced at about 20 m intervals. We surveyed each cross-section with a surveyor's level and leveling rod at 15.2 cm spatial resolution. Bank-full width (w) was measured for each transect and cross section depth (d) was calculated by averaging all depth measurements across the bank-full width. The $w:d$ was determined by dividing the bank-full width by average cross-section depth and channel area was determined by multiplying bank-full width by average cross section depth.

RIV04

Title: Moss cover in streams in wooded riparian areas and areas where canopy had been cut at Konza Prairie

Purpose: To test if woody removal in a riparian zone allowed the system to rebound to a grassland stream state.

Date data commenced: 01/01/2010

Date data terminated: 12/31/2020

Methods:

We surveyed in-stream moss cover upstream of the weirs on watersheds N2B and N4D in May of 2011 (immediately after the cutting treatment) during baseflow and 8 January 2021 under dry conditions. Briefly, a $\frac{1}{4}$ m² quadrat was randomly placed within the active stream channel every 6 meters along the stream channel until 10 transects in the main channel of N2B and N4D were sampled. The square quadrat had a grid with 50 equally sized sub-quadrats and proportion of moss cover was estimated for each sub-quadrat. The data were represented as the proportion of moss cover.

RIV05

Title: Leaf mass in streams in wooded riparian areas and areas where canopy had been cut at Konza Prairie

Purpose: To test if woody removal in a riparian zone allowed the system to rebound to a grassland stream state.

Date data commenced: 01/01/2010

Date data terminated: 12/31/2020

Methods:

Organic material in the stream channel was surveyed in four locations on 8 January 2021 in dry channels that had not flowed since woody leaf senescence. The four sites were 1) upstream of the weir in the removal area watershed N2B (39.08995 N, 96.58900 W), 2) downstream of removal area in watershed N2B in a channel with intact riparian forest (39.08994 N, 96.58859 W), 3) further downstream of the previous point, in mature gallery forest and at one of the long-term litter deposition sites (39.09867 N, 96.88967 W), and 4) in the control watershed N1B, in an area of younger riparian forest with small trees (39.08656 N, 96.57703 W). Each site had 10- 0.25m² quadrats spaced over a few hundred meters. We took 10-20 paces upstream and blindly cast the quadrat into the channel. All leaves, small wood, and seed parts were collected from inside the quadrat and weighed in the field. For larger samples, the entire damp sample was weighed and a ~30g subsample was placed in a paper bag to assess damp mass to dry mass. The entire sample was taken and weighed for smaller samples. The subsamples were weighed again and then the bag alone after 3 days drying at 60°C. The proportion of damp to wet mass for each sample was used to correct dry mass of the entire sample. A subset of 18 samples of collected leaves was asked at 450°C to determine ash free dry mass (AFDM) to dry mass ratios. This factor was 0.74 with a standard deviation of 0.07.

RIV06

Title: Remote sensing in and around riparian zones at Konza Prairie

Purpose: To measure changes in woody vegetation covers over time in riparian and non-riparian locations.

Date data commenced: 09/01/2020

Date data terminated: 09/01/2022

Methods:

In three watersheds, we established a series of permanent plots with a 20-meter radius. Two users used photo interpretation to draw polygons around each vegetation type (performed by Brynn Ritchey and Zak Ratajczak). These shape files were used to tabulate the total cover of each vegetation type, which is reported in this dataset. Measurements were taken for riparian and non-riparian locations in three watersheds:

N1B (with data for 1978, 2002, 2010, 2012, 2019, and 2020)

N2B (with data available for 1978, 2002, 2003, 2010, 2012, 2014, 2016, 2018, 2019, and 2020)

N4D (with data for 1978, 2002, 2010, 2012, 2019, and 2020)

For further details, see Keen RM, Nippert JB, Sullivan PL, Ratajczak Z, Ritchey B, O’Keefe K, Dodds WK. Impacts of Riparian and Non-riparian Woody Encroachment on Tallgrass Prairie Ecohydrology. *Ecosystems*. 2022 Apr 13:1-2.
<https://doi.org/10.1007/s10021-022-00756-7>

RIV07

Title: Seeding rates woody removal of a tallgrass prairie stream and riparian zone after a decade of woody vegetation removal

Purpose: To assess the potential ability of the riparian zone to shift to a grassland state based on cutting alone and cutting with replanting.

Date data commenced: 01/01/2010

Date data terminated: 12/31/2020

Methods:

We planted plots with seed collected from nearby species in fall 2010. Seeds were collected from 70 species, with six species (listed by mass), *Sorghastrum nutans*, *Andropogon gerardii*, *Antennaria neglecta*, *Elymus canadensis*, *Silphium laciniatum*, and *Silphium integrifolium*, making up more than half of the total seed mass added. The seeding rate was relatively high (~38 kg/ha). This was about twice the recommended rate for grassland restoration, since we did not clean or test seeds for viability. While we did not clean seed (e.g., no pappus removed, seeds like those of purple prairie clover not removed from pods, wild coffee seeds not removed from fruits, etc.), Echinacea seeds were separated from the capitulum. Seed for each species was stored in paper bags at room temperature until time of seeding. Seeds were sown onto each plot and gently raked on 28 December 2010 shortly after woody cutting. A paper bag was prepared for seed addition in each treatment plot with all species mixed together. Seed was hand broadcast, passing over the treatment plot at least three times in the process of emptying each bag to ensure even spread and that any smaller seeds settling to the bottom would be spread throughout.

RMP01

Title: Rainfall manipulation plot study at Konza Prairie

Purpose: Rainfall Manipulation Plots facility (RaMPs) is a unique experimental infrastructure that allows us to manipulate precipitation events and temperature, and assess population community, and ecosystem responses in native grassland. This facility allows us to manipulate the amount and timing of individual precipitation events in replicated field plots at the Konza Prairie Long-Term Ecological Research (LTER) site. Questions we are addressing include:

1. What is the relative importance of more extreme precipitation patterns (increased climatic variability) vs. increased temperatures (increased climatic mean) with regard to their impact on grassland ecosystem structure and function? Both projected climate change factors are predicted to decrease soil water availability (see below) but the mechanisms by which this resource depletion occurs differ.
2. Will altered precipitation patterns, increased temperatures and their interaction increase opportunities for invasion by exotic species?
3. Will long-term (6-10 yr) trajectories of community and ecosystem change in response to more extreme precipitation patterns continue at the same rate as initial responses from years 1-6? Or will non-linear change occur as potential ecological thresholds are crossed? And will increased temperatures accelerate these responses?

Date data commenced: 01/01/1997

Date data terminated: 12/31/2012

Methods:

Aboveground NPP and species composition:

ANPP is estimated from end of season harvests of sixteen 0.1 m² quadrats per RaMP, eight from heated areas and eight from ambient temperature areas. All biomass is sorted into graminoid and forb components. Because the site is burned annually and not grazed, the biomass harvested represents ANPP. Canopy cover, plant species richness and diversity are estimated in 1-m² permanent plots in each RaMP (twice in a growing season to sample early and late season species; Collins et al. 1998). Pretreatment data were collected in 1997 from all RaMP plots and was collected prior to warming the subplots.

For more information about this study, please see: www.konza.ksu.edu/ramps/

SDR01

Title: Intra-clonal stem demography of *Cornus drummondii* in response to fire and browsing at Konza Prairie

Purpose: Intra-clonal stem density, natality, mortality, flowering and relative growth rate within discrete *Cornus drummondii* shrubs in response to fire frequency (4- vs 20-yr burn intervals) and simulated browsing. Tagged stems within individual shrubs were tracked and measured at the beginning and end of each growing season in 2018 and 2019 to assess the interactions of fire and browsing on stem demography.

Date data commenced: 05/01/2018

Date data terminated: 09/15/2019

Methods:

Data were collected in the lowlands of watersheds 4B and 20C in 2018 and 2019 at Konza Prairie Biological Station. In 2015, 40 discrete *Cornus drummondii* shrub clones were chosen in the lowlands of watersheds with a 4-yr and 20-yr burn frequency. Half of the shrubs in each burn frequency were randomly selected for a simulated browsing treatment. From 2015-2019, browsing was simulated by stripping 50% of current year shoot growth by hand from each stem once a month from May-September. See O'Connor et al. 2020 and dataset FWE01 for more detail. We used this browsing experiment to assess the effects of fire and simulated browsing on stem density, growth, reproduction, and demography within individual shrubs.

We established 0.25 m wide transects through the longest axis of each shrub. In May 2018, we tagged each stem, including all stems originating from basal buds at the soil surface and rhizomatous buds, within each transect using insulated copper wire around the shoot base. Stems were counted again in August and the number of dead (with tag) and new stems (no tag) were recorded. Tagging and counting were repeated in April and September of 2019.

Data Collection:

- Stem densities – number of live stems within the transect divided by the area (m²) of the transect.
- Flower production – number of flowering stems within each transect during peak flowering. The proportion of flowering stems within each transect can be calculated as the number of flowering stems divided by the total number of stems within the transect.
- Recruitment – number of new stems within each transect at the end of the growing season. Proportion of new stems can be calculated as the number of new stems at the end of the season divided by the total number of stems at the end of the season.
- Mortality – number of tagged stems dead at the end of the growing season. Proportion of dead stems can be calculated as the number of dead stems with tags at the end of the season divided by the number of live stems at the beginning of the season.

- Flowering effort – number of inflorescence clusters on 5 stems on the periphery and 5 stems in the center of each shrub.
- Stem height – height measured to the last leaf-bearing node on the tallest shoot axis of 5 stems on the periphery and 5 stems in the center of each shrub. Height was measured in June and August in 2018 and May and August in 2019.
- Stem basal diameter – basal diameter of 5 stems on the periphery and 5 stems in the center of each shrub. Basal diameter was measured in June and August in 2018 and May and August in 2019.
- Shrub area – calculated using an ellipse area equation by measuring the length of the longest axis of each shrub and perpendicular width at the end of each growing season.
- Leaf area – leaf area of 4 randomly selected leaves from each shrub was measured using the LEAFSCAN smartphone application (leafscan.com).

SEA01

Title: Soil extracellular enzyme activity data from the Belowground Plot Experiment

Purpose: To assess enzyme-mediated feedbacks to increase in nutrient availability from long-term fertilization.

Date data commenced: 01/05/2015

Date data terminated: 12/31/2015

Location of sampling: Belowground Plot Experiment

Frequency of sampling: Monthly for soil extracellular enzyme activities

Variables measured: Activities of extracellular enzymes: Beta-glucosidase, cellobiohydrolase, N-acetylglucoaminidase, leucyl aminopeptidase, acid phosphatase, and phenol oxidase. Soil chemistry: total carbon and nitrogen and gravimetric water content.

Methods:

Soil samples from each plot were collected as composites of four 2 cm diameter, 15 cm deep soil cores.

Form of data output: Extracellular enzyme activities were measured using short-term, room temperature assays with fluorometric organic substrates (Saiya-Cork et al. 2002, SBB 34(9): 1309-1315.; Zeglin et al. 2013, Ecology 94(10): 2334-2345.). Total carbon and nitrogen were quantified using thermal conductivity. Gravimetric water content was measured by drying soil samples overnight at 105 Celsius and weighing water mass loss.P

Quality assurance: -999 or NA were used for quality control / quality assurance.

Instrumentation: FilterMax F5 Multimode Microplate Reader; Flash EA 1112 NC Analyzer

SIC01

Title: Isotopic composition of select archived soil cores from Konza Prairie

Purpose: Study concentration and isotopic composition of soil carbon and nitrogen

Date data commenced: 1982

Date data terminated: 2015

Location of Sampling Stations:

Soil was sampled along the LTER vegetation transects in the lowlands of 001d, n01b, 020b, and n20b.

Frequency of Sampling:

Five sampling periods (1982, 1987, 2002, 2010, and 2015)

Variable Measured:

C concentration, N concentration, $\delta^{13}\text{C}$, and $\delta^{15}\text{N}$

Field Methods:

An Oakfield Soil Sampler, with a coring diameter of $\frac{3}{4}$ " (19.05 mm) was used to obtain soil to a 25 cm depth. All samples were stored at 5-10°C until they could be processed. The samples were sieved through a #5 U.S.A. Standard Testing sieve (4 mm opening). All visible rocks and large root fragments are subsequently removed from the sieved soil. Sorting takes approximately 20 minutes for each composite sample. Locations of Archived Soil Samples: 1982, 1987, 2002, 2010, 2015 – Bushnell Annex 121.

Laboratory Methods:

Dried soil samples were ground and homogenized using a Wig-L-Bug amalgamator. Samples were packed at 4 mg in pressed tin capsules and analyzed via continuous flow on a ThermoFinnigan Delta Plus isotope ratio mass spectrometer via a ConFlo II interface with a CE 1110 elemental analyzer. The isotopic ratio of samples was calculated using delta notation as:

$$\delta = [(R_{\text{sample}}/R_{\text{standard}})-1]*1000$$

where R is the ratio of heavy to light isotope for the sample and standard, respectively. For carbon, the laboratory working standards were calibrated relative to the international standard VPDB, while for nitrogen, the laboratory working standard were calibrated relative to the international standard atmospheric air. The within-run variability estimated as the SD of working standards was always <0.05‰ for carbon and <0.10‰ for nitrogen, and the between-run variability, estimated as the difference between the measured value of a working standard and its long-term calibrated value, was always <0.05‰ for carbon and <0.15‰ for nitrogen.

SLP01

Title: Leaf physiology in response to fire and climate within *Cornus drummondii* shrubs at Konza Prairie

Purpose: Woody encroachment threatens the loss of remaining grasslands. Clonal shrubs are of particular concern because of their ability to resprout after disturbance, spread vegetatively, and share resources among interconnected stems. These traits contribute to the encroachment of deep-rooted clonal shrubs in tallgrass prairie. In this study, we investigated how leaf physiological traits differ among interconnected stems within a dominant encroaching shrub in tallgrass prairie, *Cornus drummondii*. Accounting for intra-clonal differences among stems in response to disturbance may be useful to more accurately parameterize models that predict the effects of shrub encroachment on ecosystem processes. Gas exchange rates, water potential, carbon isotopes, and leaf traits were collected from the periphery to the center of discrete *C. drummondii* shrubs. Measurements took place in the summers of 2015 and 2018

Date data commenced: 01/01/2015

Date data terminated: 12/31/2018

Methods:

Experimental methods: These data were collected in the lowlands of watersheds 4A and 4B at Konza Prairie Biological Station. In 2015, we collected leaf gas exchange and water potential from six shrubs in the lowlands of 4B. We sampled five ramets equidistant from the periphery of the clone to the center of the clone on six sampling dates throughout the growing season. In 2018, we collected leaf gas exchange, leaf isotopes, and leaf functional traits from the periphery and center of 20 shrubs located in the lowlands of 4B and 20 shrubs located in the lowlands of 4A. 4A was burned in April of 2018 and we measured resprouting shrubs that experienced 100% aboveground mortality after fire.

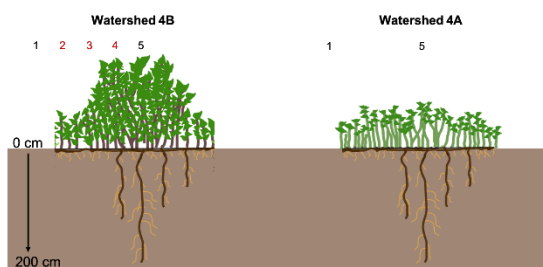


Figure 1. Diagram of sampling locations within *C. drummondii* shrubs. We sampled shrubs within watershed 4B in 2015 and 2018. Red numbers indicate ramet locations that were only sampled in 2015. In 2018, we sampled resprouting shrubs in watershed 4A.

Data collection methods:

- **Shrub Area:** Shrub canopy area was estimated using an ellipse area equation by measuring the length of the longest axis and its perpendicular width through each discrete shrub.
- **Gas Exchange:** Instantaneous gas exchange rates were taken using a Li-6400XT open system gas analyzer (Li-Cor, Inc., Lincoln, NE). In 2015, gas exchange measurements were taken on 5 ramets within each shrub clone six times throughout the growing season (May-September). In 2018, gas exchange measurements were taken on one stem on the periphery and one stem in the center of each shrub four times throughout the growing season. Gas exchange measurements were collected between 10:00 and 15:00 h.
- **Water Potential:** In 2015, predawn and midday water potentials were measured six times

throughout the growing season. Leaves for predawn water potentials were collected approximately one hour prior to dawn and leaves used for midday measurements were collected at approximately 12:00 h. Leaves were equilibrated for one hour in a dark, moist, high [CO₂] plastic bag to ensure stomatal closure. Leaf water potential was measured using a Scholander pressure chamber (PMS Instrument Company, Albany, OR).

- Carbon isotopes: Four young, fully expanded leaves from the center and four leaves from the periphery of each shrub were collected for stable isotope analysis. Leaves were dried at 60°C for 72 hours. For each shrub, the leaves from the periphery and center were each combined and ground. We measured stable carbon isotopic composition at the Kansas State University mass spectrometry lab. See Nippert et al. 2013 for a similar protocol.
- Leaf traits: Leaf traits were measured on the same leaves collected for carbon isotope analysis. We measured leaf area of fresh leaves using the LEAFSCAN smartphone application (leafscan.com). We then dried the leaf tissue at 60°C for 72 hours and subsequently weighted leaf dry mass.

SMB01

Title: Variation in soil respiration and bacterial community due to species-specific plant-soil history at Konza Prairie

Purpose: We conducted a “home vs. away” plant-soil feedback greenhouse experiment using two C3 grass species (*Bromus inermis* and *Pascopyrum smithii*) grown in soil collected from Konza Prairie. We used a closed-circuit CO₂ trapping method and isotopic analysis to differentiate between root-derived and SOM-derived CO₂ production. We investigated how soil chemistry and soil bacterial communities differed in soils with a history of *B. inermis* vs soils with a history of *P. smithii*.

Date data commenced: 06/01/2015

Date data terminated: 05/01/2017

Location of Sampling Stations:

HQ

Frequency of Sampling:

One sampling event

Variable Measured:

aboveground biomass, belowground biomass, total soil carbon, total soil nitrogen, NH₄, NO₃, microbial biomass C, total soil respiration, SOM-derived CO₂, root-derived CO₂, bacterial community richness, bacterial community evenness

Field Methods:

All soil used in the greenhouse study was collected in 2015 from the upper 15 cm of an area near the HQ of the Konza Prairie Biological Station, Manhattan, Kansas, USA. The soil was a silty clay loam (fine, mixed mesic Pachic Argiustoll) classified by the USDA Soil Survey as part of the Dwight-Irwin complex. After collection, all soil was passed through a 6 mm mesh sieve, coarsely hand-picked to remove roots and stored air-dried in barrels until the greenhouse experiment began the following year.

Greenhouse Methods:

In June 2016, the stored soil was distributed into 180 pots (10 cm diameter x 25 cm deep) constructed from PVC pipe with airtight bottom caps. To allow better drainage and water accumulation below the soil, a 0.5 kg nylon sandbag (~5 cm depth) was placed at the bottom of each pot. To inoculate the stored soil with a fresh microbial community, a small amount of freshly collected soil from the field site was mixed into each pot (3% fresh soil in each pot). Commercially available seeds of the native C3 grass *Pascopyrum smithii* and the invasive C3 grass *Bromus inermis* (Stock Seed Farms, Murdock, NE, USA) were germinated in potting soil in the greenhouse. One week after germination, individual seedlings were transplanted into each PVC pot so that half of the soils would be conditioned by *P. smithii* and half of the soils would be conditioned by *B. inermis* (Figure 1). After ten weeks of growth, the plants were

harvested, and coarse root biomass was removed. Fine root biomass was picked from the soil and removed as much as possible.

Soils conditioned by the same plant species were pooled, homogenized, and redistributed into new pots. Newly germinated seedlings of *P. smithii* and *B. inermis* were transplanted into pots with soil that had been conditioned by the same species for the second round of soil conditioning. After ten weeks, the aboveground and belowground biomass of the plants was harvested. Fine root biomass was removed from the soil as much as possible.

For the experimental portion of the greenhouse study, the 180 pots were split into two ‘Plant Legacy’ treatments based on the conditioning phase described above: 1) soil conditioned by *B. inermis* or 2) soil conditioned by *P. smithii*. Each pot was also assigned one of the three ‘Current Plant’ treatments: 1) one *B. inermis* seedling or 2) one *P. smithii* seedling, as well as 3) a no plant control.

Thirty pots, 5 of each Plant Legacy x Current Plant treatment, were destructively sampled each month over a 3-month growing period, so that after 12 weeks, 90 of the pots were sampled. For the remaining 90 pots, aboveground and belowground biomass was harvested at the end of the first round of growth, fine roots were removed from the soil as much as possible, and soils belonging to the same treatment were pooled, homogenized, and redistributed in preparation for a second round of growth and sampling. A new seedling of either *P. smithii* or *B. inermis* was transplanted into each pot in the same distribution as the first round of the greenhouse experimental phase and allowed to grow for a second 12-week period. Throughout the conditioning and experimental phases of the greenhouse study, soils were kept at 60% water-filled pore space. Pots were watered with DI-H₂O via a 50cc syringe attached to a ~15 cm perforated tube inserted into the soil at the time the pots were filled. Additionally, to prevent anoxia, the soils were aerated for ~1 hour every day via a vacuum pump connected to each pot to draw air through the soil. Pots also were rotated within the greenhouse every 2 weeks to avoid potential artefacts of location.

A closed-circuit CO₂ trapping method (Cheng et al., 2003) was used to collect belowground CO₂ efflux after 4, 8, and 12 weeks of growth during each round of the experimental phase. Thirty pots were randomly selected for measurement on each trapping date (2 Plant Legacy x 3 Current Plant x 5 replicates). Briefly, liquid silicone rubber (Silicones-Inc., High Point, NC, USA) was spread over the surface soil of each pot to form an airtight seal separating aboveground and belowground portions of the pots and plants, which allowed sampling of CO₂ released from soil and intact plant roots. After allowing the silicone rubber to cure for 16-18 h, each pot was connected to a soda lime column and the soil atmosphere was scrubbed for 40 minutes with the closed-circuit system to ensure that we were only trapping CO₂ produced during the measurement period. For 24 hours, all the CO₂ produced belowground in each pot was trapped by bubbling air via air stones in the trapping circuit through bottles containing 300 ml of 0.25M NaOH. After trapping was completed, the silicone rubber was removed, and the pots and plants were destructively sampled. Two subsamples of soil were collected from each pot. One subsample was stored at 4°C for subsequent nutrient and microbial biomass analysis, and the other (collected from the rhizosphere) was stored at -20°C for subsequent microbial community analysis. In pots that contained plants, aboveground and belowground biomass was collected. After rinsing the belowground biomass with DI-H₂O, all plant biomass was dried at 60°C for 48 hours and weighed.

Laboratory Methods:

Soil microbial biomass C (MBC) was determined using a fumigation-extraction method (Jenkinson and Powlson, 1976) and calculated as the difference between fumigated and unfumigated samples. For each unfumigated sample, ~15 g of moist soil was extracted with 75 ml of 0.5M K₂SO₄ on a shaker table at 200 rpm for 1 hour. Extracts were passed through a 0.4 µm polycarbonate filter and stored at -20°C. Another set of soil samples was placed into a vacuum desiccator and fumigated with chloroform under a vacuum for 48 hours. Following fumigation, the beaker of chloroform was removed, and residual chloroform was removed from soil samples by repeatedly applying a vacuum and opening the chambers. Total organic C in the extracts was measured with a Shimadzu TOC-L dissolved carbon analyzer (Shimadzu, Kyoto, Japan).

We measured total %C and total %N of soil using a coupled combustion-gas chromatography Flash EA 1112 C/N autoanalyzer. Also, approximately 12 g of moist soil was extracted with 50 ml of 2N KCl on a shaker table at 200 rpm for 1 hour. Extracts were passed through a 0.4 µm polycarbonate filter and frozen for later analysis. Extractable inorganic nitrogen (NH₄⁺ and NO₃⁻) was determined colorimetrically at the Soil Testing Lab at Kansas State University (Manhattan, KS, USA).

Total CO₂ respired from soil and plant roots was determined from the inorganic C content of the NaOH traps, measured on a Shimadzu TOC-L dissolved carbon analyzer (Shimadzu, Kyoto, Japan). To determine $\delta^{13}C$ of the respired C, trapped CO₂ was precipitated as SrCO₃ by adding excess 1 M SrCl₂ to a subsample of the NaOH traps. The precipitate was rinsed with DI-H₂O once every 24 hours for 7 days to neutralize pH, and then dried at 105°C for 24 hours. The $\delta^{13}C$ of the SrCO₃ was measured using a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Chesire, UK) at the UC Davis Stable Isotope Facility (Davis, CA, USA). The proportion of CO₂ derived from SOM was calculated according to the following isotope mixing model equation: %SOMco2 = $(\delta t - \delta P) / (\delta s - \delta P) * 100$, this equation δt represents the $\delta^{13}C$ value of the trapped CO₂. The δP represents the $\delta^{13}C$ value of the plants. In this study, we used a value of -27.5‰ for δP . The δs represents the $\delta^{13}C$ value of the soil. We used a value of -16.24‰ for δs based on analysis of the collected bulk soil.

Genomic DNA (gDNA) was extracted from soils using a MoBio PowerSoil Extraction kit (QIAGEN, Carlsbad, CA, USA) according to the manufacturer's instructions. Successful gDNA extraction was confirmed using a NanoDrop spectrophotometer (ThermoFisher Scientific, Waltham, MA, USA). The bacterial and archaeal 16S rRNA gene was targeted using universal bacterial primers (515F/806R) and amplified using PCR according to Earth Microbiome Project protocols (Caporaso et al., 2012) with a few exceptions. First, we added 2 µl of 1% Bovine Serum Albumin, 0.25 µl of MgCl₂ and double the amount of gDNA to each reaction well. Additionally, PCR was only run for 25 cycles instead of 35. Each sample was amplified in triplicate, and amplification was confirmed using gel electrophoresis. Each sample was normalized by DNA concentration and combined into a single amplicon library. The combined library was cleaned using a QIAquick Gel Extraction Kit (QIAGEN, Carlsbad, CA, USA) according to included instructions. The library was sequenced using a 2 x 150 paired-end Illumina MiSeq run, with v2 reagents and a 10% PhiX spike, in the Integrated Genomics Facility at Kansas State University (Manhattan, KS, USA). Raw sequence data were initially processed with the QIIME1 software (Caporaso et al., 2010b). Sequences were quality filtered, joined and

demultiplexed, and assigned to operational taxonomic units (OTUs) at 97% sequence similarity. OTUs were aligned to the GreenGenes v. 12_10 16S rRNA gene reference database, and taxonomy was assigned using the RDP classifier (Caporaso et al., 2010a; DeSantis et al., 2006; McDonald et al., 2012; Wang et al., 2007). Chimeras were identified with CHIMERASLAYER and removed from further analysis (Haas et al., 2011). From this point forward, the data were exported for further processing using the phyloseq package within the R statistical software (McMurdie and Holmes, 2013). After ensuring that the DNA extraction and PCR blanks contained a low OTU richness, the decontam package (Davis et al., 2017) identified and removed 168 likely contaminant sequences using a X2 analysis. Any sample that retained fewer than 15,000 reads at this point was removed from further analysis. Next, we filtered the taxa so that the data only included OTUs from the kingdom Bacteria. Additionally, we excluded any OTUs associated with mitochondria or chloroplasts. Finally, we removed rare OTUs (<10% relative abundance). Alpha diversity, evenness, and phylum-level response to soil conditioning were estimated using these data. OTU richness and evenness were estimated by rarefying each sample to have the same number of reads as the sample with the least number of reads (14,462 reads). The final dataset included 11,017,633 reads in 140 total samples that were affiliated with 14,307 unique OTUs.

SMP01

Title: Spatial variation of soil microbial processes under *Cornus drummondii* shrubs of varying size at Konza Prairie, 2017

Purpose: Study soil chemistry of soil collected under individual *Cornus drummondii* shrub islands

Date data commenced: 2017

Date data terminated: 2017

Location of Sampling Stations:

Soil underneath ten *Cornus drummondii* islands in the lowlands of watershed 020c

Frequency of Sampling:

One sampling event

Variable Measured:

C concentration, N concentration, inorganic N concentration, P concentration, organic matter content, microbial biomass C, microbial biomass N, potential β -glucosidase activity, potential phosphatase activity, potential NAG-ase activity, and potential LAP-ase activity, shrub size, potential C mineralization rate, $\delta^{13}\text{C}$ value of respired CO_2 .

Field Methods:

Ten distinct dogwood islands were randomly selected within watershed 020c. Five cm diameter x 15 cm deep soil cores were taken at four locations within each dogwood island along a linear transect: the center, the midpoint, the edge, and the ecotone with grassland. The center was defined as the intersection of perpendicular transects running the length and width of the dogwood island. The midpoint was defined as the halfway point between the center and the furthest edge. The edge was defined as the outer perimeter of the dogwood island canopy, and the ecotone was defined as the halfway point between the edge of the dogwood island of interest and the nearest neighboring dogwood island. Shrub island size was calculated by ellipse area equation using the lengths of the two perpendicular transects. All soil was kept on ice until it could be placed in short-term storage at 4 °C.

Laboratory Methods for SMP011 dataset (soil chemistry and soil microbial processes):

Laboratory methods: On the day after sampling, soils were passed through a 4 mm sieve. A small subsample of soil from each location was dried at 60 °C for 48 hours to determine gravimetric water content. Soil used for nutrient analyses was stored at 4 °C. Soil used for extracellular enzymatic activity analyses was stored at -20 °C.

Total C and N content of each soil sample was determined via dry combustion using a LECO TruSpec CN combustion analyzer. Total organic matter was determined by a slightly modified loss on ignition protocol outlined in Combs and Nathan (1998). Briefly, 1 g of soil was dried at 150 °C for two hours and then combusted at 400 °C for three hours. Available P was determined by the Mehlich-3 procedure (Mehlich 1984). The above analyses were performed at the Soil

Testing Lab at Kansas State University.

Fifty ml of 2N KCl was added to 12 g of field moist soil and placed on an orbital shaker table at 200 rpm for 60 minutes to extract soil NH₄⁺ and NO₃⁻ (Bremmer and Keeney 1966). Extracts were passed through a 0.45 μm polycarbonate filter and stored at -20°C until they were analyzed colorimetrically for NO₃⁻ and NH₄⁺ in a flow analyzer at the Kansas State University Soil Testing Lab.

Microbial biomass C was determined using the chloroform fumigation-extraction method (Jenkinson and Powlson 1976). A subsample of each soil sample was placed into a chamber, fumigated by boiling chloroform under a vacuum, and kept in the fumigation chamber under a vacuum for 48 hours. A vacuum pump was used to remove all chloroform from the chamber after fumigation was completed. Fumigated and unfumigated samples were extracted by combining 15 g of field moist soil and 75 ml 0.5 M K₂SO₄ and placing on an orbital shaker table at 200 rpm for 60 minutes, then passing through a 0.45 μm polycarbonate filter. Extracts were stored at -20°C until they were analyzed for total organic C with a Shimadzu TOC-L. Microbial biomass C was defined as the difference in dissolved organic C between fumigated and unfumigated subsamples.

Total nitrogen content in microbial biomass was determined by taking a subsample of the K₂SO₄ extracts and subjecting them to a persulfate digest (D'Elia et al. 1977; Cabrera and Beare 1993). This oxidizes all forms of nitrogen to NO₃⁻. After being reduced to NO₂⁻ by a cadmium coil, N concentrations in the extracts were determined colorimetrically using an Alpkem OI Analytical Flow Solution IV. Microbial biomass N was defined as the difference in N between fumigated and unfumigated subsamples.

We tested the potential activity of four extracellular enzymes (Sinsabaugh et al. 1999; German et al. 2011): β-glucosidase (BG; a C-acquiring enzyme), N-acetyl-glucosaminidase (NAG; a N-acquiring enzyme), phosphatase (PHOS; a P-acquiring enzyme), and leucine-aminopeptidase (LAP; a N-acquiring enzyme). We used 200 μM solutions of 4-methylumbelliferone-b-D-glucoside, 4-methylumbelliferone-N-acetyl-b-glucosaminide, 4-methylumbelliferone-phosphate, and L-leucine 7-amido-4-methylcoumarin as substrates, respectively. For each soil sample in each assay, we created a slurry of 1 g of soil in 100 ml of 50 mM acetate buffer (pH 5). In 96-well plates, we pipetted 200 μl of the soil slurry with 50 μl of the substrate solution. There were six analytical replicates for each sample in each assay as well as a blank, a negative control, a reference standard, three quench standards, and six soil blanks. For BG, NAG, and PHOS assays, we incubated the plates in the dark at room temperature for 2 hours. Assays for LAP activity were incubated for 16 hours. Once the incubations were complete, we added 10 μl of 0.5 N NaOH solution to raise the pH and stop the assays. Finally, we used a FilterMax F5 plate reader to collect fluorescence data.

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<https://doi.org/10.4319/lo.1977.22.4.0760> (link is external)

Laboratory Methods for SMP012 dataset (potential carbon mineralization):

On the day after sampling, soils were passed through a 4 mm sieve. A small subsample of soil from each location was dried at 60 °C for 48 hours to determine gravimetric water content. Approximately 300 g of soil from each sample was placed into an 8 cm wide x 15 cm deep mason jar (Day 0). Total CO₂ respired and the δ¹³C-CO₂ value was measured at 1, 3, 5, 7, 10, 34, and 77 days after the start of the incubations. Starting at Day 0, soils were wetted to 60% water-filled pore space. Throughout the duration of the incubation, each jar was regularly weighed and rewetted to maintain constant soil moisture. Before each measurement, the time at which the lids were sealed was recorded. Total CO₂ concentration and the δ¹³C-CO₂ value was determined by taking a gas sample of the headspace of each jar through a rubber septum. Two blanks were also measured on each day to account for background CO₂ of the room. The CO₂ concentration and stable isotopic value of the gas sample was analyzed with a Picarro Cavity Ringdown Spectrometer (model G2101-i, Picarro Inc., Santa Clara, CA). The isotopic ratio of samples was calculated using delta notation as:

$$\delta = [(R_{\text{sample}}/R_{\text{standard}}) - 1] * 1000$$

where R is the ratio of the heavy to light isotope for the sample and standard, respectively. Delta values were calculated relative to the international standard for carbon, VDBP. For measurements of CO₂ concentration, the spectrometer had a precision of ± 200 ppb for ¹²C-CO₂ and ± 10 ppb ¹³C-CO₂. The precision for δ¹³C values was ± 0.3‰.

SMR01

Title: Konza Prairie grassland soil microbial responses to long-term management of N availability

Purpose: Study soil microbial responses

Date data commenced: 11/01/2014

Date data terminated: 12/12/2015

Location of Sampling Stations:

Belowground Plots

Frequency of Sampling:

Monthly between November 2014 – December 2015

Variable Measured:

Year, month, location, plot, block, burn, GWC, DNA

Methods:

To address the predictions, soils were collected from the Belowground Plot Experiment (BGPE) at Konza Prairie Biological Station: a 30-y factorial field manipulation of N fertilization and burning. Surface soils (0-15 cm) were sampled monthly between November 2014 – December 2015, including one-week post fire (April) and post fertilization (June). Genomic DNA was extracted from each sample of qPCR and PCR for Illumina MiSeq library sequencing of the prokaryotic 16s rRNA gene and fungal ITS, to estimate population and community dynamics of soil microbes. Soil environmental characteristics and plant communities were measured in July 2015 to evaluate correlations between plant and microbial communities, and environmental variability.

Bacterial 16S rRNA gene and fungal ITS copy number:

Population sizes of bacteria and fungi were estimated using quantitative PCR (qPCR) assays using Bio-Rad CFX CONNECT system with Bio-Rad SsoAdvanced Universal SYBR Green Supermix (Bio-Rad Laboratories, Hercules, CA, USA). For 16s rRNA gene and ITS assays, respectively, ~1 ng (exact amount calculated on a per sample basis) template gDNA was added to a 10 μ L PCR volume, with 0.02% and 0.04% final BSA concentration, 100 nM and 500 nM final primer concentrations, using established primer sequences and thermal cycler programs (Fierer et al. 2005, AEM 71: 4117-4120). Standard curves for 16S assays were prepared using *E. Coli* ATCC 25922 at 5×10^0 – 5×10^{-6} ng μ L⁻¹ DNA concentrations, and ITS standard curves were prepared using *Candida albicans* SC5314 at 5×10^0 – 5×10^{-6} ng μ L⁻¹ concentrations; successful curves were accepted at 100 +/- 15% efficiency and $R^2 > 0.99$. All assays included no-template controls and melting curves, which confirmed that only gene copies from templated soil gDNA were quantified, and 3 technical replicates were run per sample. Soil gDNA yield (μ g DNA g⁻¹ dry soil) was used to normalize marker gene copy number per p dry soil.

SNE01

Title: Species richness, community evenness (Evar) and ANPP effects of nitrogen addition across a gradient of 8 levels in a semi-arid shortgrass steppe and a mesic tallgrass prairie, 2014-2018

Purpose: To identify the minimum level of nitrogen required to elicit an initial change in ecosystem function and community structure and to describe the pattern of change as nitrogen levels increase.

Date data commenced: 08/01/2014

Date data terminated: 08/01/2018

Location of Sampling Stations:

Variable Measured:

Whole plot level diversity, richness and plant species cover; and Subplot level diversity, richness and plant species cover.

Methods:

The Chronic Addition of Nitrogen Gradient Experiment (ChANGE): the effect of a gradient of nitrogen addition on productivity in a semi-arid shortgrass steppe and a mesic tallgrass prairie for the first five years of fertilization (2014-2018).

Study Sites:

This experiment is conducted in two grassland ecosystems: a semi-arid shortgrass steppe and a mesic tallgrass prairie.

The semi-arid shortgrass steppe site is located within the Central Plains Experimental Range in northeastern Colorado, USA (40° 50' N, 104° 45' W). Elevation at the study site ranges from 1,600 to 1,700 m, and mean annual precipitation is 366 mm (Griffin-Nolan et al. 2018). The study site is located in a pasture that has been ungrazed by cattle since 2000, with minimal topographic variation and relatively homogeneous vegetation (Griffin-Nolan et al. 2018). Perennial and annual forb species make up the bulk of diversity at the site.

The mesic tallgrass prairie site is located within the Konza Prairie Biological Station in the Flint Hills of northeastern Kansas, USA (39° 05' N, 96° 35' W) (Watershed R1B). This site has never been plowed. Elevation at Konza ranges from 320 m to 444 m and the mean annual precipitation is 835 mm (Collins et al. 2021). The study site is located in an ungrazed, upland site within a watershed that has been annually burned since 2001 (Collins et al. 2021).

Experimental Design:

This experiment was established in 2013. It is a randomized complete block design, in which 8 different levels of nitrogen (0, 2.5, 5, 7.5, 10, 15, 20, and 30 g m⁻²) were randomly assigned to one of eight 5 x 5 m plots within each of six blocks (8 treatments *

6 blocks = 48 total plots per site). Blocks were arrayed on the landscape so that there was a minimum 10 m distance between each block. Plots within each block were arrayed in two rows of four plots, with each plot separated by a 1 m buffer. Nitrogen in the form of time-release urea was evenly applied by hand to each 5 x 5 m plot during late May or early June. Plot-level diversity (Shannon's diversity index: H') was calculated by summing the total number of species from all subplots within a plot. Plot-level diversity (Shannon's diversity index: H') was calculated from the average cover of each species across all 12 subplots within a plot.

Plant Diversity and Community Composition:

At each study site, plant community composition was surveyed within a 1 x 1 m permanent sampling area (located in a corner of the designated 2.5 x 2.5 m plot, with a 0.5 m buffer from the edge of the plot) at the beginning (late May or early June) and end (mid- to late-August) of the growing season in each year of the study. Cover of each species was visually estimated as percentage aerial cover to the nearest 1% for species under 50% abundance and to the nearest 5% for species above 50% abundance for each species rooted within the sampling area. When early and late measures of cover were estimated for a species, the maximum cover estimate was used. Cover estimates of species within each plot were used to calculate species richness and species evenness (Evar; Smith and Wilson 1996) using the `community_structure()` function within R's (version 4.4.1; R Core Team 2024) `Codyn` package, (version 2.0.5; Hallett et al. 2016, 2018).

Aboveground Net Primary Productivity Measurements:

ANPP was estimated at peak biomass (late August/early September) each year by clipping all vegetation at ground level within two 20 x 50 cm quadrats, located within the same subplot as the plant composition measurements. Quadrats were moved yearly to prevent resampling over time. Biomass was dried for 48 hours at 60 °C, and weighed to the nearest 0.01 g. Quadrat values that fall outside the 99th percentile for weight were excluded as outliers. Mean biomass (excluding previous year's dead) across the two quadrats in each plot was multiplied by 10 to estimate ANPP (g m⁻²). Only forbaceous and grass biomass is used to calculate ANPP, since woody biomass is rare, and not representative of the site. The effect of nitrogen addition on productivity is calculated as the absolute differences in ANPP between control plots and fertilized plots within a block.

Quality assurance:

All outlier values have been assessed for accuracy.

SPW01

Title: Spatial and physical characteristics of bison wallows on Konza Prairie since 2011

Purpose: To characterize spatial and physical attributes of bison wallows at the Konza Prairie Biological Station in northeastern Kansas.

Date data commenced: 01/03/2011

Date data terminated: 12/31/2020

Methods:

Aerial mapping: Bison wallows were mapped in 2011 using aerial photographs from Riley County Geographic Information Systems (<https://gis.rileycountyks.gov/> (link is external)), and again in 2019 using aerial imagery obtained from the National Agriculture Imagery Program (United States Department of Agriculture Farm Service Agency, Salt Lake City, Utah). We then used Esri (Environmental Systems Research Institute Inc., Redlands, California) ArcMap to identify wallows at scales of 1:669 (2011) and 1:663 (2019), using a fishnet grid to track areas that had been searched. A wallow was identified as any oval area with bare or partially bare ground, or with a clearly defined border of vegetation different from that surrounding it. For the purposes of this study, we used only those wallows with 50% or less plant cover, resulting in the identification of 3,231 wallows in the 2011 dataset and 2,936 wallows in the 2019 dataset. Because of differences in scale and resolution, data from 2011 and 2019 were analyzed separately. Density of mapped wallows were analyzed based on fire frequency, elevation, and slope.

Landscape descriptors (frequency of fire, elevation, and slope) were identified using Esri ArcMap 10.8 software. Fire frequency is part of the overall experimental design of KPBS and is applied to each watershed within the bison-grazed enclosure at intervals of 1, 2, 4, or 20 years. Data on slope and elevation were obtained using a 2-meter digital elevation model generated from Lidar (Light Detection And Ranging) data. Elevation was classified into quartiles, resulting in four levels of elevation corresponding to 333 to <360, 360 to <388, 388 to <415, and 415 to 443 meters above sea level. Slope was classified into three levels corresponding to 0 to <6, 6 to 12, and >12 degrees, allowing for absorption of small variations in slope into surrounding areas for smoothing purposes. The overlaid combination of fire frequency, elevation quartile, and slope levels defined 4,174 unique area polygons. We then counted the number of wallows in each polygon for the 2011 and 2019 datasets.

Physical characterization: Between 8 June and 13 August 2020, we surveyed a subset of wallows randomly selected from the 2011 dataset. For each wallow surveyed, we collected two measurements of the longest axis and two measurements of the shortest axis of the wallow. We also took measurements of depth every 61 cm (i.e. 2 feet) along the longest axis of the wallow. Length and width (in meters) of each wallow were defined as the average of the two measurements collected of the longest and shortest axes, respectively. We calculated the surface area, A (m²), of each wallow using an elliptical approximation, such that $A = \pi * (\text{length}/2) * (\text{width}/2)$, where π is the mathematical constant 3.14159. Wallow depth (in centimeters) was defined as the median depth measurement along the longest axis. Wallow volume, V (m³), was

approximated using the formula for an ellipsoid divided by two, such that $V = \frac{1}{2} (4/3 * \pi * (\text{length}/2) * (\text{width}/2) * (\text{depth}/2))$. For each measured wallow, the slope (in degrees) of the surrounding terrain was obtained from ArcGIS data. We also recorded whether the wallow was located on a grazing lawn or not. A grazing lawn was defined by the presence of short-cropped grasses and abundant forbs. Finally, we recorded whether the wallow contained any aquatic or terrestrial vegetation in a binary yes/no manner.

Additional Information:

Wallows2011: Data collected by Adam Skibbe and Thomas Kuhn;

Wallows2019: Data collected by Pam Blackmore and Andrew Woodrum;

Wallows2020: Data collected by Kentin Brummett, Micah Dunn, Jake Marsh, Kalea Nippert, Mike Prekopy, John Rhodes, Amelia Richter, and Caden Searcy, who were supervised by Amanda Kuhl and Pam Blackmore.

SRH01

Title: Seed release height and terminal velocity of forb species at Konza Prairie

Purpose: Height of seed release values recorded at Konza Prairie Biological Station (2022-2024) and terminal velocity measurements of seeds collected from those same species. Intended to for seed dispersal estimates.

Date data commenced: 06/01/2022

Date data terminated: 08/30/2024

Methods:

Seed release height samples were opportunistically sampled across Konza between May and December in 2022 through 2024. For each individual, we recorded the minimum and maximum height of seed release (distance between ground and natural height of inflorescence – i.e. not “stretched”) and collected mature fruits. We dried fruits at 60° C for at least two weeks. Once fruits were dried, we removed all other tissues not relating to dispersal from seeds. We were unable to collect seed for *Asclepias viridiflora* or *Astragalus plattensis*.

To estimate seed terminal velocity, we used the same apparatus used by Sullivan et al. 2018: a 10.16 cm PVC tube equipped with light sensor arrays that detect seed presence through light disruptions. We dropped seeds from 1 m above the first light sensors, ensuring they reached terminal velocity. Ten species were measured with 20 trials using different seeds, however for five species (*Comandra umbellata*, *Hieracium longipilum*, *Penstemon grandifloras*, *Ratibida columnifera*, and *Dalea purpurea*), we were only able to conduct 10-19 trials due to limited seeds. When possible, we dropped only one seed at a time. However, for particularly small seeds, the sensors were unable to consistently detect the seeds. Instead, we dropped seeds in multiples, attempting to drop as few seeds as possible; number dropped ranged from 2 to 20 seeds. We were unable to get velocity data for *Artimisia ludoviciana* or *Achillea millefolium*.

SRM01

Title: ShRaMPs (Shrub Rainout Manipulation Plots): interactive effects of drought and fire on grass and shrub physiology and productivity at Konza Prairie

Purpose: ShRaMPs (Shrub Rainout Manipulation Plots) is a drought x fire experiment aimed at understanding the interactive effects of drought and fire frequency on tallgrass prairie communities experiencing varying degrees of shrub encroachment. Passive rainout shelters were constructed over existing, mature shrub islands and co-existing herbaceous communities on neighboring 1-year and 4-year burn watersheds (K1B and K4A). Shelters were either 'control' (ambient precipitation) or 'drought' (~50% precipitation reduction). A variety of leaf-level (gas exchange, water potential, turgor loss point, leaf $\delta^{13}C$) and whole-plant level (herbaceous and shrub biomass, plant water uptake) variables were measured during the 2019-2022 growing seasons to determine the physiological responses of a dominant C4 grass (*Andropogon gerardii*; big bluestem) and an encroaching clonal shrub (*Cornus drummondii*; rough-leaf dogwood). Soil volumetric water content was measured on-site for the duration of the experiment.

Date data commenced: 05/01/2019

Date data terminated: 08/31/2022

Research Location: Konza Prairie Biological Station, boundary between watersheds K1B and K4A.

Methods:

Leaf gas exchange: Measurements were conducted every 3-4 weeks throughout each growing season (2019-2022) using a LI-COR 6400XT or 6800 infrared gas analyzer. Two individual plants per species were measured in each shelter during each sampling round. For all measurements, reference CO₂ concentration was set to 400 $\mu\text{mol mol}^{-1}$, PAR (photosynthetically-active radiation) was set to 2000 $\mu\text{mol m}^{-2} \text{s}^{-1}$, and relative humidity was maintained between 50-65%. Measurements were taken between the hours of 10:00 and 13:00 on clear, sunny days.

Leaf water potential: Predawn and midday leaf water potential measurements were conducted every 3-4 weeks during each growing season (2019-2022) on the same dates as leaf gas exchange measurements. Midday measurements were conducted between the hours of 12:00 and 13:00, and predawn measurements were taken 1-2 hours before dawn, either on the same day as midday measurements or the next morning. Three replicates per species, per shelter were collected during each sampling round. For *C. drummondii*, the youngest, most distal leaves at the top of a ramet were collected, and for *Andropogon gerardii*, the youngest fully expanded leaf from each individual was collected. Measurements were conducted using a Scholander pressure chamber.

Turgor loss point: In 2022 only, leaves from *C. drummondii* and *A. gerardii* were collected at five time points during the growing season. At each time point, one sample

per species was collected from each shelter. Measurements of osmotic potential at full turgor were conducted using a VAPRO Vapor Pressure Osmometer (Model 5600).

Plant/soil water isotopes: Non-photosynthetic tissue from *C. drummondii* (stem tissue) and *A. gerardii* (root crown tissue) was collected every 3-4 weeks throughout each growing season (2019-2022). Tissue was collected from 3-5 individuals and composited into one sample per species per shelter. Samples were immediately sealed in exetainer vials and refrigerated. Surface soil (0, 10, 20 cm depth) was collected at the same time as plant tissue collection. Under each shelter, root-free soil was collected from each depth and immediately sealed in exetainer vials and refrigerated. Deep soil cores (1 m) were collected from each watershed using a hydraulic push-corer (540MT Geoprobe Systems) in the early (June / July) and late (August / September) growing season each year. Water from each sample was extracted using cryogenic vacuum distillation and analyzed for $\delta^{18}\text{O}$ and $\delta^2\text{H}$ on a Picarro WS-CRDS isotopic water analyzer at K-State.

Plant biomass: Herbaceous vegetation was collected at the end of each growing season (late August / early September; 2019-2022) to determine annual net primary productivity (ANPP). Biomass was collected from 0.1 m² frames in two subplots per shelter. Samples were sorted into graminoid, forb, and woody biomass. Previous year's dead biomass was separated for samples from the 4-year burn shelters. For shrub aboveground biomass, *C. drummondii* stems were counted and stem basal diameters were measured in one subplot per shelter during the winter following each growing season (2019-2022). The same subplot was measured each year. Stem density was recorded for each shelter and aboveground biomass was estimated from stem counts and diameters using allometric equations.

Leaf carbon isotopes: 3-4 leaves from *C. drummondii* and *A. gerardii* were collected for stable isotope analysis on the same sampling dates as water potential and gas exchange. Leaves were dried at 60 °C for at least 72 hours and then ground up until each sample was homogenized. Samples were then analyzed for $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, percent carbon, and percent nitrogen at K-State.

Soil moisture: Each shelter at ShRaMPs was equipped with 30 cm time domain reflectometry (TDR) probes at 10, 15, and 30 cm depths. Volumetric water content data was recorded at 30-minute intervals from 2019-2022.

Gas exchange, water potential, and leaf $\delta^{13}\text{C}$ will continue to be collected and the dataset will be updated annually.

SRP01

Title: Sequential prairie restoration experiment at Konza Prairie

Purpose: Annual aboveground net primary productivity (ANPP) from the Sequential Prairie Restoration Experiment at the Konza Prairie Long-Term Ecological Research site in Manhattan, KS USA. The data (SRP011) include ANPP from the first three years of restoration in each of three restoration sequences initiated in different years. Data correspond to subplot and whole-plot analyses. The Sequential Prairie Restoration Experiment is a block design with 4 subplots (labeled A - D) within 4 main plots (numbered 1 - 4) sequentially replicated in three blocks (Sequences 1, 2 and 3), with the restoration in each block initiated in a different year (Sequence 1 initiated in 2010, Sequence 2 initiated in 2012, and Sequence 3 initiated in 2014). 'NO-COLL' indicates that variable was not measured, A period in the dataset indicates missing data.

Plant species composition data include plant composition from the first two sequences (Sequence I restored in 2010 and Sequence II restored in 2012) in all years from 2010 to 2020 (SRP012); and from the first four sequences (I to IV restored every other year from 2010 to 2016) for the first five growing seasons in each sequence (SRP013).

Date data commenced: 01/01/2010

Date data terminated: 12/31/2020

Methods:

Aboveground net primary productivity (ANPP) (SRP011) was estimated by harvesting biomass from two 0.1 m² randomly placed quadrats (except for sequence 2 in 2012 and 2013, which had 4 replicates sampled within deer exclosures nested in each subplot) in September, at peak biomass, from each of the 16 subplots within each restoration sequences. Biomass was clipped at the end of each growing season in 2010, 2011, 2012, 2013, 2014, 2015, and 2016. Biomass was dried for 1 week at 60°C, sorted into planted species, non-planted species, and surface litter (not collected in all years), and weighed. Biomass in each subplot was multiplied by 10 to convert ANPP to units of g m⁻² y⁻¹. Missing data is represented by a period (.).

Plant species composition (SRP012) is measured twice a year in May and September, with the exception of the year when a sequence was installed and composition was not measured that May. The maximum cover of species across both time points was recorded. All subplots were sampled through the 6th growing season, after which only half of the subplots were sampled. The subplots sampled after the 6th growing season were randomly selected from each plot for each sequence and the same subplots were sampled over time. All plant species in a permanent 10 m² circular plot within a subplot were recorded, and the canopy cover of each species was estimated using a modified Daubenmire scale.

Plant species composition (SRP013) is measured twice a year in May and September, with the exception of the year when a sequence was installed and composition was not measured that May. The maximum cover of species across both time points was recorded for all subplots. All plant species in a permanent 10 m² circular plot within a subplot were recorded, and the canopy cover of each species was estimated using a modified Daubenmire scale.

VIR01

Title: Effects of invertebrate and vertebrate herbivory on tallgrass prairie plant community composition and biomass

Purpose: To examine the effects of invertebrate and vertebrate herbivores and their interactions with nutrient availability on grassland plant community composition and aboveground biomass.

Date data commenced: 05/11/2009

Date data terminated: ongoing

Location of Sampling Stations: Uplands of watershed 2C (behind the Nutrient Network plots and adjacent to the Phosphorus plots)

Frequency of Sampling:

To determine the effects of nutrient availability and herbivore removal on grassland productivity and diversity, plant species composition and end-of-season above-ground biomass are sampled yearly.

Methods:

The effects of herbivores and their interactions with nutrient availability on primary production and plant community composition in grassland systems is expected to vary with herbivore type. Although nutrient additions are known to affect plant species diversity and primary productivity, the role of herbivores in mediating the strength of these effects also remains unclear. Herbivores may alter plant responses to nutrient additions in several ways. First, herbivores can alter the plant community response to nutrient additions by either selectively feeding on particular groups of species (e.g. grasses versus forbs) or by generally opening up space, allowing for species turnover and immigration. Second, feeding by herbivores may reduce the production response to nutrient additions if the plants cannot compensate for tissue lost to herbivory. As the functional effects of vertebrate and invertebrate herbivores on plant community composition and production may vary, the interactive effects of vertebrate versus invertebrate herbivores with nutrient additions may also vary. Here we are experimentally assessing the independent and interactive effects of removing vertebrate and invertebrate herbivores on aboveground biomass and plant community composition in native tallgrass prairie. Further, we are examining whether the removal of vertebrate and invertebrate herbivores interacts with nutrient availability. By doing this, we address three related questions: 1) what is the relative strength of the effects of invertebrate versus vertebrate herbivory in a grassland system; 2) how does herbivory (invertebrate and/or vertebrate) affect the relative abundances of grasses and forbs, the two dominant plant functional types within the ecosystem; and 3) what are the consequences of these changes in composition for aboveground net primary productivity, an important ecosystem function?

We are examining the effects of invertebrate and vertebrate herbivores and their interactions with nutrient availability on grassland plant community composition and aboveground biomass in the uplands of watershed 2C at Konza Prairie (behind the Nutrient Network plots and adjacent to the Phosphorus plots). To address the relative and interactive effects of bottom-up and top-down control over grassland communities, nutrient additions, vertebrate herbivore removals, and invertebrate herbivore removals were crossed in a fully factorial design. Plots are 2 x 2 m in area and treatment replicates (N=3) are arrayed in three blocks. Plots within each block are separated by 1 m aisles, while blocks are separated by 2 m aisles.

The nutrient treatments involve the addition of relatively high levels of nitrogen, phosphorous, and potassium plus other micronutrients, each applied at a rate of 10 g m⁻² yr⁻¹. Nitrogen is added in the form of time-release urea; phosphorous is added in the form of calcium phosphate; and potassium is added in the form of potassium sulfate. The micronutrient treatment involved the addition of Scott's Micromax fertilizer, which contains calcium (6 g m⁻²), magnesium (3 g m⁻²), sulfur (12 g m⁻²), boron (0.1 g m⁻²), copper (1 g m⁻²), iron (17 g m⁻²), manganese (2.5 g m⁻²), molybdenum (0.05 g m⁻²), and zinc (1 g m⁻²). The micronutrient treatment was only applied in 2009 to prevent the build-up of these elements in the soil, some of which are toxic to plants at high levels. These nutrient additions occur once yearly at the start of the growing season.

The vertebrate herbivore removal (caged) treatment involves surrounding the entire plot with a fence. This fence consists of a 1 m high fine mesh with a 0.3 m skirt stapled to the ground, to discourage burrowing under fences. The herbivore removal treatment excludes medium- to large- vertebrate herbivores from the plots, but does not prevent access by invertebrate herbivores. Ortho Bug-B-Gone insecticide is applied to the invertebrate herbivore removal (insecticide) plots every two weeks throughout the growing season to ensure complete exclusion of invertebrate herbivores. An equal quantity of water is added to the insect control plots.

To determine the effects of nutrient availability and herbivore removal on grassland productivity and diversity, plant species composition and end-of-season above-ground biomass are sampled yearly. Plant species composition is measured in a permanent 1 m² subunit within each of the experimental plots twice per growing season, once in spring (mid-May to early-June) to determine the abundance of early season forbs and C₃ grasses, and once in fall (late-August to early-September) to determine the abundance of late season forbs and C₄ grasses. Percent cover is determined for each species to the nearest 1% using a modified Daubenmire method. Two permanent 1 m² subunits within each experimental plot are dedicated to destructive biomass sampling. The aboveground standing crop is sampled once per growing season, at peak biomass. One 0.1 m² strip is clipped in each of the two destructive sampling subunit in each plot and the location of strips is moved each year to prevent resampling. Biomass is separated (2009: to the three dominant grasses, one dominant forb, other grasses, other forbs, woody, and previous

year's dead; 2010-2012: by species; 2013-current: by functional group), dried at 60 °C, and weighed.

Light attenuation curves were developed for each plot in 2009. Light availability was measured from ground level to above the canopy at 0.1m intervals four times during the growing season (May, June, July, August) using a PAR sensor. Root biomass was measured in 2010 by taking three soil cores spaced evenly around each plot (radius=1.25", depth=15 cm), sieving the roots out of the soil, washing the roots, and drying the roots at 60 °C.

WAT01

Title: Konza Prairie Long-Term Irrigation Transect Study

Purpose: To assess the long-term response of selected vegetation and ecosystem parameters to annual burning with no water limitation.

To determine long-term changes in canopy cover, richness, and diversity of plant species in irrigated and non-irrigated uplands and lowlands.

Date data commenced: 05/01/1991

Date data terminated: ongoing

Location of Sampling Stations:

The transect and two control transects are located about 300 m (600 ft) southwest of the old stone reservoir and windmill to the west-southwest of headquarters (grid B-16). The transect runs perpendicular to the slope just south of the belowground plots on the east side of the drainage way. The area is identifiable by the line of sprinklers on 1 m risers from the 7.5 cm diameter aluminum pipe which runs a length of 140 m (460 ft) down the transect.

The area which is subject to additional water is outlined by a row of steel posts located 15 m (50 ft) on each side of the line of sprinklers. Posts are located 18 m (60 ft) apart along the transect to correspond to every other sprinkler on the line. A numbering system is laid out in reference to the sprinklers. The lower most sprinkler is 1 and the upper most sprinkler is 15. This pattern is repeated for sprinklers 16-31. Every other sprinkler has a number mounted on its riser. The steel posts have a number, which corresponds to the number on the sprinkler it is nearest. The total research area consists of the area inside the steel posts plus how much farther outside the potential wetted area the particular experiment needs to extend to get sufficient unirrigated area to compare to the irrigated area. As research areas outside the areas bounded by the steel posts is requested, individual researchers will be responsible to mark those areas with steel posts.

Walking on the area is necessary to make measurements, get samples, etc. When walking to a particular area, please walk either parallel or perpendicular to the sprinkler line and line of steel posts. When walking up the transect or perpendicular to the transect, please walk on lines directly between steel posts or lines formed by steel posts and the closest sprinkler. Researchers may walk on their plots as necessary. Walk only on the lines between steel posts and sprinklers to get to individual research areas.

When an area is assigned to a researcher it will be located with reference to the nearest sprinkler, the irrigation line, and the row of steel posts. You may mark it as you see fit.

Species Composition Plots:

Species composition conduits are located east of each riser in the irrigated transect and in the eastern control transect. Plant composition plots are marked with a conduit in

transects that are parallel to the irrigation sprinklers. Another transect that is parallel to the irrigated plots but outside the reach of the supplemental water is used as control plots. TDR probes for soil moisture measurements are located west of the sprinkler risers in the irrigation transect and in the western control transect. Biomass is harvested on the north side of the risers away from the TDR probes, and reproductive effort is assessed on the eastern side of the irrigation transect and in the eastern control transect. The non-irrigated samples are collected in a random circle 2 m away from the species composition marker. Reproductive effort is done similar. Leaves for plant xylem pressure potential measurements are collected from either side of the transect.

Sampling History:

Plant composition plots were established in 1991. Initially, 13 irrigated and 13 non-irrigated plots were sampled, but in 1992 the number of plots expanded to 30 in both treatments.

Frequency of Sampling:

Aboveground biomass is sampled in late August-October. Reproductive effort is sampled in October. Plant water potential [predawn and midday (1300 CDT)] and soil moisture is sampled at ca. weekly to 10-day intervals depending on the weather. Soil chemistry is sampled at five-year intervals. All plots are sampled for species composition once each year in late July.

Variable Measured:

- 1) Aboveground biomass
- 2) Plant reproductive effort
- 3) Xylem pressure potential in Andropogon gerardii
- 4) Plant species composition
- 5) Soil moisture and chemistry

Canopy cover of all vascular plant species in each plot is estimated. Because sampling is only conducted in the summer, the cover of early-spring plants and cool-season grasses are likely underestimated.

Methods:

Irrigation Procedures:

General Information:

A single line of full-circle sprinklers with pressure regulators below each one are spaced close together on the supply line to provide relatively uniform amount of water at locations parallel to the line. There is a gradient, in terms of water added, from most water at the line to none at the outer radius of the sprinklers (15 m from the line with no wind interference).

Scheduling of irrigation will be done according to the needs of the plants along the transect near the irrigation line. Plant stress will be monitored as the measure of when to irrigate. Nominal supplemental water needs for grass in the Manhattan area averages about 450 mm per year for cool season types. Warm season grasses will probably require less because their active growing season is shorter than for cool season types. During the growing season from June through early September, however, water use should be similar for both types of grasses, which is about 350 mm on an average year. Nominal water use

from all sources is likely to be about 6 mm per day for a fully watered condition. A nominal irrigation provides about 20 mm of water along the sprinkler line. So, two irrigations per week will be needed if no rain occurs.

A well at the reservoir provides about 12 gpm into the reservoir. An irrigation pump takes water from the reservoir and delivers it to the sprinklers at about 90 gpm. A nominal irrigation will be to run for three hours. During irrigation with the well running, the reservoir drops about 1 foot per hour. So, the reservoir, which has about 3.5 feet of working depth when full, must be within about 0.5 feet of the top (at least 3 feet on the scale in the reservoir) before a three hour irrigation can begin.

Preparing for Irrigation:

First, the well must be started far enough in advance of the time for irrigation to get the reservoir full. The fill rate will vary with the condition of the well. A nominal fill rate is 0.2 feet per hour. So, for an irrigation that begins at 9 am, and the reservoir is reading 1 foot on the scale, the well should be started at least 14 hours before irrigation is to begin to 7 pm the day before. No harm is done if the reservoir overflows. Electricity, however, is wasted and the future capacity of the well may be jeopardized if a lot of water is wasted. The well pump is controlled by the switch in the electrical control box located about 30 feet east of the windmill. It is the one with the 20 on it (top one of the two). As soon as an irrigation is finished, the well pump should be turned off. You may see some water outside the reservoir when the tank is nearly full. There is a small leak somewhere near the top of the reservoir that has not been located. The reservoir can sit full with no concern, so filling can be done as convenient.

The 24 rain gauges within the transect between Sprinklers 3 and 4 must be empty before you begin irrigating.

Performing the Irrigation:

Water should be applied when the wind is less than 10 mph (16 kph). Early morning or late evening is usually the best time, however, this does not fit well with effective use of classified staff because it involves overtime. Experience has shown that by avoiding conditions with winds in excess of 20 mph provides acceptable distribution of water on the transect. Check the local forecast as you plan your irrigation. Once you begin, it is recommended that irrigation continue even though the wind is uncooperative. Nominal watering time is three hours. The rain gauge network will provide an estimate of water applied across the transect. We assume that the distribution is similar for other locations along the transect. To carry out an irrigation do the following:

- 1) Empty the 24 rain gauges on the transect between Sprinklers 3 and 4.
- 2) Record the water depth reading in the reservoir to show how much water was removed from the reservoir.
- 3) Estimate and record the air temperature, wind direction, and wind speed on the data sheet.
- 4) Open the valve on the supply line to the pump (2 inch valve which is turned counter clockwise all the way until it stops; its several turns). Turn on the electricity to the pump, the switch in the control box located about 30 feet east of

- the windmill (the one with 30 marked on it; the bottom one of the two). The pump will run for about a minute before the sprinklers start to spray water. Record the time that all sprinklers are spraying water as the start time.
- 5) Wait three hours until pump is ready to be shut off and then do so. Shut off the well pump, too, unless you wish to begin refilling the reservoir at that time. Also, close the gate valve on the supply line to the pump by turning it clockwise (it's several turns to close it). Record the time the pump is shut off as the ending time.
 - 6) Again, record the water level in the reservoir, the air temperature, wind direction, and wind speed.
 - 7) Read the amount of water in each of the 24 rain gauges between Sprinklers 3 and 4 in the transect and empty them as you read. If you expect rain before the next irrigation, there is no need to empty them.
 - 8) Record any comments of interest or importance on the data sheet.
 - 9) Make sure that data sheet is returned to a designated place for safe keeping.

Amount of water applied:

The amount of water applied to each part of the transect will be determined from the grid of rain gauges between Sprinklers 3 and 4. It will be assumed that the distribution at other locations along the transect is similar to this location. This information will include accumulated amount of additional water referenced to the distance from the sprinkler line. The expected distribution is to have about 350-400 mm more added near the line and none out 15 m from the line. The gradient will not be exactly uniform because of wind and the nature of the sprinklers.

Plant species composition (WAT012): Due to the new treatments on the irrigation transect, we need to change the way we handle the plots in our datasets. Recall that there are 60 plots (30 irrigated, 30 control) in 2 replicate transects (plots 1-15 in transect A, 16-31 in transect B). Historically, we have simply listed the plot number and treatment to designate plots, but the treatment reversal will cause a considerable amount of confusion under this system. Therefore, we have decided to divide the plots into 4 new transects (combining previous transect and previous treatment into a single variable).

Aboveground biomass (WAT013):

Methods are identical to those in data set PAB011 except six 0.1 m² quadrats are harvested at each sampling point /sprinkler. (AK) All irrigated samples are taken on the north side of the sprinkler within 4 ft of the spigot to ensure highest possible water content (approximately 100%). Non-irrigated/control samples are collected in a random circle 2 m away from the species composition marker. Due to rock outcrop, no collections are made at sprinkler #9.

Summary of All Changes:

Only four 0.1m sq. quadrants were collected in 1991.

#26 irrigated location has a large amount of poison ivy in the vicinity. Samples collected from both sides of sprinkler instead of only north side.

Every year since 2003, #8 (irrigated) has had a large dead zone around it due to chemical removal of *B. bladhii*. Measurements are either taken outside the “normal” range or not at all (2007). A few other locations have had small spots (approximately 1 ft in diameter) from chemical removal, specific notes are made on the data sheets. These dead spots are not clipped but may force the collector to go further away from the normal collection area.

As of 1999, only samples “A”, “B”, and “C” from plots 1,2,3,13,14,15,16,17,18,29,30, and 31 (irrigated & control) are kept for further analysis. 1, 2, 3, 16, 17, and 18 are lowland. 13, 14, 15, 29, 30, and 31 are upland.

Starting with 2006 samples, “c. dead” is no longer separated from “live grass”. Categories are live, forb and woody.

Current (2009) data sheet available.

2017: samples A, B, C from 4, 5, 6, 10, 11, 12, 19, 20, 21, 26, 27 and 28 irrigated and non-irrigated will now be kept for further analysis. There have been huge changes to this project, see Dr. John Blair or Jeff Taylor for details.

2023: the final year of biomass collections

2024: woody samples were incorrectly archived. These samples were exceptionally large and should have been archived in the unground state. Through a misunderstanding, the student ground only the leaves and the smaller branches. The stems (larger than a pencil) were thrown away because they were too big for the Wiley mill. Impacted samples: 10Bi-A and 10Bi-C.

(WAT015):

We estimate density of flowering culms of *Andropogon gerardii* (ANGE), *Sorghastrum nutans* (SONU), and *Schizachyrium scoparium* (ANSC) by counting all reproductive culms in four randomly placed 0.25 m² quadrats at each sampling point. Heights of reproductive culms are measured to the nearest cm by selecting the nearest culms of each species at nine (previous manual states 3 but it has always been nine) randomly selected points at each sampling location. No harvesting occurs in this sampling scheme. Due to rock outcrop at sprinkler #9, no measurements are taken.

The Genus for little bluestem is *Schizachyrium* not *Andropogon* but we still use the ANSC code.

Summary of changes for reproductive effort (WAT015)

Every year since 2003, #8 (irrigated) has had a large dead zone around it due to chemical removal of *B. bladhii*. Measurements are taken outside the “normal” range. Other areas have had small “kill zones”; specific notes are made on data sheets. These “spots” did not impact collections: generally, these spots are less than 1 ft in diameter.

Current (2009) data sheet are available.

Xylem pressure potential:

At least seven mature leaf blades are collected at each sampling location and immediately stored in a plastic bag with wet filter paper. Leaves are transported back to the lab and xylem pressure potential is measured with a PMS Model 1000 Pressure Chamber to the nearest 0.1 MPa (1 bar). At the limestone break along the irrigation and control transect, leaves from a hackberry tree are also collected and measured.

Plant species composition (WAT012):

A surveyor's pin with a 1.78 m long chain is placed in the conduit marking each plot. Canopy cover of all vascular plant species in a 10-m sq. circular area within each conduit are estimated using a modified Daubenmire cover scale (Bailey and Poulton, 1968. Ecology 49:1-13). Cover categories are:

Class	Cover	Mid-point
1	<1%	0.5%
2	1-5%	3.0%
3	5-25%	15.0%
4	25-50%	37.5%
5	50-75%	62.5%
6	75-95%	85.0%
7	95-100%	97.5%

Raw data contains the cover class value for each species detected in the plot.

WAT02

Title: Climate legacies determine grassland responses to future rainfall regimes

Purpose: To assess how legacies of past precipitation regimes influence tallgrass prairie C cycling under new precipitation regimes.

Date data commenced: 03/01/2017

Date data terminated: 12/30/2022

Location of Sampling Stations: Konza Prairie Biological Station

Methods:

To assess how legacies of past precipitation regimes influence tallgrass prairie C cycling under new precipitation regimes, we modified a long-term irrigation experiment that simulated a wetter climate for >25 years. We reversed irrigated and control (ambient precipitation) treatments in some plots and imposed an experimental drought in plots with history of irrigation or ambient precipitation to assess how climate legacies affect aboveground net primary productivity (ANPP), soil respiration, and selected soil C pools. Legacy effects of elevated precipitation (irrigation) included higher C fluxes and altered labile soil C pools, and in some cases altered sensitivity to new climate treatments. For additional details see: Broderick, C.A., K. Wilkins, M.D. Smith, and J.M. Blair. 2022. Climate legacies determine grassland responses to future rainfall regimes. *Global Change Biology* 28:2639-2656. doi.org/10.1111/gcb.16084.

WAT03

Title: Climate legacy effects shape tallgrass prairie nitrogen cycling

Purpose: To assess how previous and current precipitation influence tallgrass prairie N cycling.

Date data commenced: 01/01/2018

Date data terminated: 12/31/2019

Location of Sampling Stations: Konza Prairie Biological Station

Methods:

To assess how legacies of past precipitation regimes influence tallgrass prairie N cycling under new precipitation regimes, we modified a long-term irrigation experiment that simulated a wetter climate for >25 years. We reversed irrigated and control (ambient precipitation) treatments in some plots and imposed an experimental drought in plots with a history of irrigation or ambient precipitation to assess how climate legacies affect N pools and fluxes. Response variables included inorganic N pools, net N mineralization and nitrification, microbial biomass N and extracellular enzyme activity potentials, and seasonal plant N concentration patterns. For additional details see: Broderick, C.A., K.M. Freeman, L.H. Zeglin, and J.M. Blair. 2022. Climate legacy effects shape tallgrass prairie nitrogen cycling. *Journal of Geophysical Research: Biogeosciences* 127, e2022JG006972, doi.org/10.1029/2022JG006972.

WAT04

Title: Root decomposition and nutrient dynamics are resistant to rainfall legacies in tallgrass prairie

Purpose: Litter decomposition is an important component of carbon (C) and nitrogen (N) cycling, and rates of mass loss and nutrient release are sensitive to current climate conditions. Growing evidence suggests that past climate conditions can exert legacies on soil C and N cycling, but little is known about how belowground decomposition dynamics relate to these climate legacies.

Date data commenced: 06/01/2019

Date data terminated: 06/30/2021

Location of Sampling Stations: Konza Prairie Biological Station

Methods:

We conducted a two-year root decomposition experiment in a long-term precipitation manipulation study in a tallgrass prairie (Kansas, USA). Irrigation was used to mitigate water stress for ~25 years; irrigation and ambient rainfall treatments were then reversed in a subset of plots, and a drought treatment was added in both previously irrigated and ambient treatments. This design allowed us to assess the independent and interactive effects of past and current precipitation regimes on root decomposition.

Results: Root litter mass loss was resistant to most climate treatments. Contrary to expectations, decomposition rates were slowest in plots with a history of long-term irrigation and fastest under drought in lowland prairie. Similarly, mass loss rates were overall faster in the drier uplands. Changes in N concentration as a function of mass loss were similar across treatments and patterns of litter N release largely tracked mass loss.

Conclusions: Changes in the decomposer community with long-term release from water stress may have led to slowed root decomposition, but these effects were subtle. Our results suggest that changes in decomposition rates are not a cause of observed climate legacy effects on C and N cycling in prairies.

WAT05

Title: Soil organic matter response to thirty years of increased precipitation at Konza Prairie

Purpose: This dataset contains carbon and nitrogen concentrations and stocks in total soil organic matter and its fractions from the Konza Prairie Irrigation Transect Experiment. The dataset also includes pyrogenic organic matter C and N, as well as microbial amino sugars and root quality measurements. Data are available for irrigated and control plots. Total pyrogenic and unburned soil organic matter C and N are available for both the upland and lowland positions at 0-5, 5-15, and 15-30cm depth increments. Fraction and root data are available at both landscape positions, but for only the 0-5cm and 5-15cm depths and 0-5 and 5-30cm depths, respectively. Amino sugar data are only available for the lowland plots for the 0-5 and 5-15cm depths.

Date data commenced: 09/01/2021

Date data terminated: 09/30/2021

Methods:

Study Site and Experimental Design

This study was conducted at the Irrigation Transect Experiment at Konza Prairie Biological Station. Konza Prairie has a mean annual temperature of 12.8°C and mean annual precipitation of 863 mm (30-year averages). Precipitation at this site exhibits high intra- and inter-annual variability and ranges from 569-1674 mm per year. The irrigation experiment is described in detail elsewhere (Knapp et al. 2001) but, briefly, the site is an annually burned native tallgrass prairie that has experienced growing season irrigation scheduled according to estimates of actual evapotranspiration (AET) and soil water availability during the growing season, with the goal of minimizing plant water limitation. Operationally, this is carried out by modeling daily estimated plant AET (Moore 2003) and conducting periodic measurements of soil water content to assess irrigation timing and amounts required to return soil water content at 0.25 cm³ cm⁻³ or higher to 30 cm depth (Knapp et al. 2001). This causes the magnitude of water addition to vary year-to-year but has resulted in a 29% increase in annual precipitation on average which also has slightly decreased interannual variability. This water addition increased soil moisture by 4.5% on average for years with comparable data (2006-2009, 2013, 2017-2021), although this is highly variable within and among years, and also slightly decreased intra-annual variability. The experiment transect spans a topographic gradient, with the upland soils classified as fine, mixed mesic Udic Haplustolls (0-10cm: 15% sand, 58% silt, 27% clay) and the lowland soils classified as fine, mixed Pachic Argiustolls (0-10cm: 15% sand, 51% silt, 34% clay; Broderick et al. 2022a). The site is dominated by perennial grasses, primarily *Andropogon gerardii*, *Sorghastrum nutans*, *Schizachyrium scoparium*, and *Panicum virgatum*. The site has two irrigation transects, initiated in 1991 and 1993, respectively, and two non-irrigated control transects. From here forward, we refer to the irrigated treatment as the increased precipitation treatment. For each transect (2 each in the upland and lowland), each treatment (control versus

increased precipitation) is replicated 3 times, providing a total of 24 plots (2 landscape positions x 2 treatments x 2 transects x 3 replicates).

Sampling In September 2021, we performed soil coring at each plot. We took 4 cores per plot using a 5.25 cm diameter push corer to 30 cm, where soil depth allowed, since some upland plots had shallower soil profiles. In the field, we separated each core into three depth increments: 0-5 cm, 5-15 cm, and 15-30 cm, and bulked the 4 cores, maintaining each depth increment. This provided 72 individual observations ($n = 24$ plots x 3 depths). Soils were then transported to Colorado State University in coolers for subsequent analyses.

Soil analyses:

All soil samples were sieved through 8 mm mesh and a subsample was subsequently sieved through 2 mm mesh. We collected roots and coarse material (aboveground plant material and rocks) during sieving and used the weight of these and the soil to calculate bulk density and to determine root biomass distribution (Mosier et al. 2021). For root biomass, we only report coarse roots (from 8 mm sieving) since they were the dominant root mass in the soil and roots from 2 mm sieving were unaffected by treatment or landscape position. We used air-dried 2 mm sieved soil to perform a combined density and size fractionation following Haddix et al. (2020), on the 0-5 cm and 5-15 cm depth soils ($n = 48$). Briefly, 10.5 g of soil was shaken with deionized water and then centrifuged and filtered through a 20 μm nylon filter to retrieve the DOM pool. The soil was then centrifuged with sodium polytungstate at a density of 1.85 g cm^{-3} to separate the light and heavy fractions of SOM. The light, floating, fraction was aspirated as free POM (fPOM). The remaining soil (the heavy fraction) was then dispersed using 0.5% sodium hexametaphosphate and 12 glass beads. After shaking for 18 hours, the slurry was poured over a 53 μm sieve, with the fraction passing through designated as MAOM and the fraction >53 μm designated as occluded POM and heavy, coarse OM (oPOM+hcOM; sensu Leuthold et al. 2022). Each fraction was subsequently weighed to determine recovery, which was 98.3% on average and varied from 94.6-102.7%. Concentrations of C and N in SOM, fPOM, oPOM+hcOM, and MAOM were measured on a VELP 802 elemental analyzer (VELP Scientific, Inc., Long Island, New York). Concentrations of C and N in DOM were measured on a Shimadzu TOC-L (Shimadzu Scientific Instruments, Inc., Columbia, Maryland).

We measured amino sugars in the bulk soil as a proxy for microbial necromass, which is thought to be a precursor for MAOM formation (Liang et al. 2017). We performed amino sugar measurement on the 0-5cm and 5-15cm depth samples, as with the fractionation, and limited this analysis to the lowland soils ($n = 24$). We followed the procedure of Zhang and Amelung (1996) to determine the amount of muramic acid (MurA), glucosamine (GluN), and galactosamine (GalN). Briefly, the soils were acid digested for breaking up amino sugar polymers, then the three amino sugar monomers were purified, and derivatized for measurement. For acid hydrolysis, dry soils containing approximately 0.3 mg N were mixed with 6 M HCl at 105°C for 8 h. The hydrolysates then underwent

several purification steps. First, samples were filtered through 55 mm glass fiber filters and evaporated to dryness on a rotary evaporator at 52°C under vacuum. Residues were then dissolved in deionized water (DI) and brought to a neutral pH before centrifugation to remove salts. The supernatant was then freeze-dried, resuspended in methanol, dried using N₂ gas at 45°C, re-dissolved in 1 ml DI, and lyophilized. For derivatization, the sample was heated with a reagent (hydroxylamine hydrochloride and 4-(dimethylamino) pyridine in pyridine-methanol) and then with acetic anhydride at 75-80°C.

Dichloromethane was then added to the sample and excess reagent was removed following washing with HCl and DI. The sample was then dried and resuspended in ethyl acetate-hexane (1:1) for measurement. Samples were analyzed on an Agilent 7890B GC (Agilent Technologies, Santa Clara, CA, USA) that was equipped with a HP-5 column (30 m length × 0.25 mm diameter × 0.25 μm thickness) and flame ionization detector. Myo-inositol and methylglucamine were used as an internal standard and recovery standard. The contents of individual amino sugars were calculated based on the internal standard. Total amino sugars were determined as the sum of MurA, GluN, and GalN. Total microbial necromass C was calculated as the sum of bacterial and fungal necromass C. For bacterial necromass C, we converted MurA using a conversion factor of 45, and for fungal necromass C, we subtracted out bacterial content of GluN and converted corrected GluN using a conversion factor of 9 (Joergensen 2018, Liang et al. 2019):

$$\text{Bacterial necromass C} = \text{MurA} \times 45 \quad (\text{Eq. 1})$$

$$\text{Fungal necromass C} = (\text{GluN}/179.17 - (2 \times \text{MurA}/253.23)) \times 179.17 \times 9 \quad (\text{Eq. 2})$$

We estimated pyrogenic C and N (PyC and PyN) using hydrogen pyrolysis (Wurster et al. 2012, McBeath et al. 2015). Subsamples of 250mg of soil were combined with an amount of molybdenum catalyst approximately equal to 1% of soil organic C for each subsample. This was done using an aqueous/methanol solution of ammonium dioxodithiomolybdate. The dried, catalyst-loaded subsamples were pressurized with 15 MPa of hydrogen with a sweep gas flow of 5 L min⁻¹ in the hydrogen pyrolysis reactor (Strata Technology Ltd., Middlesex, UK). The temperature was ramped to 250 °C at a rate of 300 °C min⁻¹, then at 8 °C min⁻¹ to a final temperature of 550 °C, which was held for 5 min. Following hydrogen pyrolysis, the remaining material was weighed and C and N abundance was determined on a Costech elemental analyzer (Costech Analytical Technologies, Inc., Valencia, CA) that was crosschecked to the VELP elemental analyzer (above) to ensure values were comparable. Post-hydrogen pyrolysis C and N were corrected for the amount of C and N loaded into the reactor.

Root quality analyses:

In addition to soil analyses, we also analyzed root quality. We focused on roots, rather than aboveground material, because this site is annually burned and so roots are the more quantitatively important form of unburned plant inputs that would influence SOM in this system. All root analyses were performed on coarse roots (collected during 8 mm sieving) and root material from 5-15 and 15-30 cm depths were combined to ensure sufficient material for the analyses. We determined acid unhydrolyzable residue (AUR) and cellulose contents in the roots using the ANKOM Acid Detergent Fiber and Acid

Detergent Lignin methods (ANKOM Technology 2022). Briefly, 0.45-0.55 g of ground root material were measured into 25 μm porosity filter bags (F57 filter bag, ANKOM Technology, Macedon, NY). Filter bags were placed in an ANKOM A200 (ANKOM Technology, Macedon, NY) and agitated for 1 hour in acid detergent solution containing 93.2% water, 4.8% sulfuric acid, and 2% cetyltrimethylammonium bromide (Midland Scientific, Inc., Omaha, NE). Bags were then rinsed with deionized water and dried to 105°C and weighed to determine acid detergent fiber (W1). Dried bags were then submerged in H₂SO₄ for 3 hours and agitated every 30 minutes to remove cellulose. They were then rinsed with deionized water until the pH was neutral and then dried to 105°C and weighed to determine AUR + ash (W2). Bags were then ashed in a muffle furnace at 525°C for three hours to remove AUR and weighed to determine residual ash (W3). Cellulose and AUR were determined as the difference between W1 and W2 and W2 and W3, respectively.

We also analyzed the amount of hot water extractable (HWE) material in the roots using the method by Tappi (1981), as modified by Soong et al. (2015a). Since HWE-C is highly correlated with leaching of dissolved organic C during early phases of plant decomposition, we use it as a proxy for readily available plant compounds (Soong et al. 2015a). We digested 0.35 g of root material cut into 1 cm pieces with deionized water at 100°C for 3 hours. We then filtered the mixture through a 20 μm nylon mesh to obtain HWE (< 20 μm) and the hot water residue (> 20 μm). The HWE was then frozen until being run on a Shimadzu TOC-L (Shimadzu Scientific Instruments, Inc., Columbia, Maryland) to obtain HWE-C and HWE-N.

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Data

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WEE01

Title: Impacts of riparian and non-riparian woody encroachment on tallgrass prairie ecohydrology

Purpose: Plant xylem water samples were collected from *Cornus drummondii* (rough-leaf dogwood), *Andropogon gerardii* (big bluestem), *Quercus macrocarpa* (bur oak), and *Quercus muehlenbergii* (chinquapin oak) during the summer of 2016. Soil cores were also collected during the summer of 2016 to collect soil water from the surface to 200 cm depth. Isotope values ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) were analyzed for each water sample to determine depth of plant water uptake.

Date data commenced: 06/01/2016

Date data terminated: 08/31/2016

Location of Sampling Stations: N2B.

Methods:

Collection / processing of soil water isotope samples: Three deep soil cores (2 m length, 5.162 cm diameter) were collected outside of the riparian corridor in watershed N2B. Cores were extracted with a hydraulic-push corer (540MT Geoprobe Systems, Salina, KS). After collection, cores were immediately stored in sealed plastic coring tubes in a laboratory refrigerator at 1-2 °C. Cores were subsampled at 10, 20, and 30 cm, then every 25 cm for the remainder of the core. When the core was cut, root-free subsampled soil was immediately placed into exetainer vials (LabCo Ltd, UK) and stored at 1-2 °C. Soil water was extracted from each soil depth for 55-65 minutes using the cryogenic vacuum distillation method.

Collection / processing of plant xylem water isotope samples: At each site, non-photosynthetic tissue was collected from each species in May, June, July, and August of 2016. For each woody individual, 10-15 cm of stem tissue (from stems ≤ 1 cm diameter) were collected and immediately placed in an exetainer vial. For grasses, crown tissue was collected and stored in the same way. All samples were immediately put on ice and then stored at 1-2 °C. Xylem water was extracted using the cryogenic vacuum distillation method.

Isotope analyses: All water samples were analyzed for $\delta^{18}\text{O}$ and $\delta^2\text{H}$ on a Picarro WS-CRDS isotopic water analyzer. ChemCorrect software was used to identify if spectral interference by organic contaminants occurred during analysis of soil and plant water samples – contaminated samples were removed from further analysis. Isotopic ratios were expressed in per mil (‰) relative to V-SMOW (Vienna Standard Mean Ocean Water). The long-term precision of this instrument using in-house standards was <0.3 ‰ for $\delta^2\text{H}$ and <0.15 ‰ for $\delta^{18}\text{O}$.

Methods from: Keen, R.M., Nippert, J.B., Sullivan, P.L., Ratajczak, Z., Ritchey, B., O’Keefe, K. and Dodds, W.K., 2023. Impacts of riparian and non-riparian woody encroachment on tallgrass prairie ecohydrology. *Ecosystems*, 26(2), pp.290-301.

WER01

Title: Elevated CO₂ counteracts effects of water stress on woody rangeland-encroaching species at Konza Prairie

Purpose: To determine how juvenile woody encroachers respond physiologically to elevated CO₂ and chronic water stress.

Date data commenced: 11/01/2016

Date data terminated: 04/30/2017

Location of Sampling Stations: Fort Collins, CO at the USDA-ARS Crops Research Laboratory greenhouse complex

Experimental Methods:

This experiment occurred in Fort Collins, CO at the USDA-ARS Crops Research Laboratory greenhouse complex. We used two greenhouse bays and set the CO₂ concentrations for each bay to either 400 ppm or 800 ppm. The bays were maintained at a temperature of 30° C during the day and 21° C at night with a 12-hour photoperiod. The bays were lit with HID lighting. We grew four different woody plant species (*Cornus drummondii*, *Gleditsia triacanthos*, *Juniperus osteosperma*, and *Rhus glabra*) in a blocked design with CO₂ concentration treatments in the two separate bays, and nested within each bay was a chronic water stress treatment and control water treatment. The water treatments were randomized within each bay. We also rotated the CO₂ treatments and the plants subject to those treatments between the bays biweekly. Native soils were used for each woody plant. The water treatments were determined based on the volumetric water content for each pot and species throughout the study. The chronic water stressed plants never had a volumetric water content more than 20% for *C. drummondii*, *G. tricanthos*, *R. glabra* and 10% for *J. osteosperma* because of soil texture. The control plants were always watered to fully saturated soils. Watering occurred once a week.

Data Collection Methods:

1. Gas Exchange: Instantaneous gas exchange rates were taken using a Li-6400XT open system gas analyzer (Li-Cor, Inc., Lincoln, NE). Gas exchange measurements were taken every two weeks from 1000 hrs to 1600 hrs for the full duration of the experiment. Leaves that did not fill the cuvette chamber were photographed on 1 cm² grid paper using an iPhone 5c camera (8 MP) and then leaf area estimated using imageJ software to correct the gas exchange parameters measured. CO₂ concentrations were matched to the greenhouse bay to match the CO₂ treatment (400 ppm, 800 ppm).
2. Biomass: At the end of the greenhouse experiment all woody plant species were cleaned with DI water to remove particulates, separated by tissue type (i.e., roots, stems, leaves) and dried for 72 hours at 60°C before being weighed.

3. Starch Analysis: Several grams of tissue were harvested from each woody plant species at the end of the greenhouse experiment. All tissues were cleaned with DI water to removal all the dirt impurities, microwaved for 90 seconds, and then dried for 48 hours at 60°C before being ground using a Wig-L-Bug® grinder. Then all the samples had the starch extracted and were analyzed colormetrically using a spectrophotometer (O'Connor et al. 2000. Ecology 101:e02935).

WES01

Title: Woody encroachment impacts on the subsurface at Konza Prairie

Purpose: Soil sampling pits across three hillslope positions - toeslope, backslope, and summit - were dug in 2020 in watershed N4D (burned every 4 years) and N1D (burned annually) to characterize the impacts of woody encroachment on subsurface soil physical, chemical, and biological properties. Pits were hand-dug to 120 cm in the toeslope position and to 60 cm deep at the backslope and summit positions. Soil pits in N4D were dug directly under dogwood shrubs (*Cornus drumondii*) while pits in N1B were dug under grasses and forbs. Soil pit faces were photographed to determine root fractions with depth, soil monoliths were taken to characterize soil macroporosity with depth while soil cores were taken in each horizon for water retention analysis. Soil sensors were also installed at four soil depths at the toeslope position and 3 soil depths at the backslope and summit positions to record half hourly soil moisture, soil temperature, soil water potential, soil electrical conductivity, and soil carbon dioxide, and soil oxygen. In addition, geophysical measurements were taken in N4D using time-lapse electrical resistivity in 2023.

Date data commenced: 07/01/2020

Date data terminated: 08/30/2023

Methods:

We measured the fraction of soil volume containing fine and coarse roots using images from three soil pits in watershed N4D and three soil pits in watershed N1B. After opening each pit, the face was cleaned and the surface of the pit face was photographed. Each image was overlain with a 1x1 cm grid and analyzed using ImageJ software. The presence or absence of fine roots (diameter < 1 mm) and coarse roots (diameter > 1 mm) was noted for each grid cell. Only presence/absence and not count data were recorded. For cells containing both fine and coarse roots, the presence of only the coarse root(s) was recorded given their greater volume. The number of grid cells with roots were summed and then divided by the total number of cells evaluated to provide a root abundance fraction (fine, coarse, and total) for each 1-cm thick soil layer.

The face of each soil pit was cleaned and soil horizons were described using the Natural Resources Conservation Service Field Book for Describing and Sampling Soils (Schoeneberger et al., 2012).

WES013 (electrical resistivity monitoring): We conducted a rainfall simulation from August 23 to 24, 2023 to test differences in soil water infiltration and drainage beneath grass and shrubs. A grass and shrub plot were established in N4D. A 24.5 m-long transect that passed through each plot was established for monitoring electrical resistivity (ER). The center of the grass plot was at 7 m along the transect and the center of the shrub plot was at 16.5 m along the transect. The mid-point of the

transect marked the transition from predominantly grass to predominantly roughleaf dogwood. The transect was also positioned along an elevation isoline to avoid topographic effects of both the rainfall simulation and the ER measurements. We installed 48 electrodes spaced every 0.5 m along the transect and monitored soil electrical resistivity using a Syscal Pro resistivity meter (IRIS Instruments, France). We used a dipole-dipole configuration with 735 quadripoles. Each quadripole was stacked 3 to 5 times for QA/QC. ER acquisition took place during five data acquisition periods from August 22 to 24, during which multiple ER surveys were automatically collected approximately every 30 minutes, resulting in 40 total data sets. We collected three data sets on August 22 to map natural variability prior to the rainfall simulation. We then collected several data sets during each of three rain pulses from August 23 to 24, and the final collection period took place before dismantling the setup on August 24.

Sampling protocol: Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., 2012. Field book for describing and sampling soils. Version 3.0 Natural Resources Conversation Service. National Soil Survey Center, Lincoln, NE.

WPE01

Title: Assessing the value added of NEON for using machine learning to quantify vegetation mosaics and woody plant encroachment at Konza Prairie

Purpose: To compare two methods of classification (random forests and support vector machines) with these two freely available remotely sensed aerial images to determine if and how much NEON adds to classification accuracy and determine which method of machine learning was more accurate.

Date data commenced: 06/01/2021

Date data terminated: 12/30/2022

Methods:

The purpose of our research is to determine which method of machine learning and which aerial imagery (NAIP or NEON) more accurately classified vegetation on Konza, specifically Eastern Red Cedar. We collected training polygons using a high-precision GPS on various locations around Konza, tracing trees, shrubs, and open areas of grassland by walking around them. We collected training polygons from June to August 2021. Training points were supplemented with computer-drawn polygons, which were traced using a combination of the 2020 NEON RGB-10 cm imagery and publicly available 1 m² RGB in ArcGIS. All training points were merged together then plotted on a raster stack, where the value of each layer for each pixel was extracted and placed in an Excel file. The data was then split, with a random 70% used to train the model and 30% used to evaluate the model.

We created six models in R: two different machine learning methods (random forests and support vector machines) with three aerial images (NAIP, NEON, and NAIP+NEON stacked together). We used 9 bands from NAIP, 8 bands from NEON, and 17 for the full raster stack. NAIP imagery provides 4 bands (red, green, blue, and infrared), and we calculated 5 more (red neighborhood, green neighborhood, blue neighborhood, infrared neighborhood, and normalized difference vegetation index [NDVI]). NAIP NDVI was calculated in R and therefore, is not included in the table of inputs. We also used 8 bands from NEON (enhanced vegetation index [EVI], normalized difference nitrogen index [NDNI], normalized difference latent heat index [NDLI], soil-adjusted vegetation index [SAVI], atmospherically resistant vegetation index [ARVI], NDVI localized, NDVI neighborhood, and canopy height [LiDAR]). In R, we used packages ‘e1071’ and ‘randomForest’ to create our support vector machines and random forest models, respectively. Models were trained using the training data and their accuracies assessed using our evaluation data. Finally, the models were used to classify the entire area of Konza by classifying each pixel in the rasterstack. The output of the classification is a list, so we utilized a Konza aspect raster, set all values to NA, and filled them in with a classified values, creating a classified vegetation map of Konza.

WPE02

Title: Shrub stem data to quantify woody encroachment in Konza watersheds from 2020, 2022, and 2023

Purpose: Woody plant encroachment (WPE) is one of the most widespread and acute threats affecting grasslands worldwide. Nature-based solutions to reversing WPE in mesic grasslands have proven largely ineffective, with decades of frequent prescribed fire failing to reverse WPE in some instances.

Date data commenced: 01/01/2020

Date data terminated: 12/31/2023

Location of Sampling Stations: 2C, 2D, 4B, 4F, K1B, K2A, K4A, N1B, N2A, N2B, N4D, 1D, N1A.

Variable Measured:

Methods:

The shrub counts and woody veg meta data have the same methods, where shrub counts is the data file where the diameters were sampled and collected, and woody veg meta data is the document that has all the physical plot locations and gps points of the plots and transects used to collect the shrub counts data. All data was entered, then checked 3 times to ensure entered correctly, following the same protocol as other LTER data.

Shrub counts: Along each transect, we established 0.5 x 0.5 m subplots at 2 m intervals, resulting in 30 subplots per plot. In each sub-plot, we measured the species for each stem at least 0.5 m tall and used digital calipers to measure stem diameter at 0.5 m height. We repeated measurements in 2022 and 2023 to determine changes in WPE. All sampling occurred over 2 weeks each June. We used allometric equations to convert stem diameters into stem density, height and leaf area.

Taxonomic Protocols: broken into a four-letter species code, with genus representing the first two letters and species the last two letters. *Cornus droumundii* (CODR), *Rhus glabra* (RHGL), *Prunus americana* (PRAM), *Rhus aromatica* (RHAR), *JUVI* (*juniperus virginiana*), and *Gleditsia tricanthos* (GLTR).

Woody veg meta: Starting in 2020, we established 24 plots across similar topography (avoiding gullies) and soil types (deeper lowland soils typical of the Tully series) in each catchment. We placed plots with double randomization and at least 20 m between the edge of each plot. From the center of each plot, we established three 20 m transects, with a common centroid and 120° of rotation between transects.

WRV01

Title: Riparian woody removal vegetation survey on watershed N2B at Konza Prairie

Purpose: To survey the vegetation before and after riparian woody removal.

Date data commenced: 05/01/2010

Date data terminated: 12/31/2011

Location of Sampling Stations: N2B

Frequency of Sampling:

Before and after removal of woody riparian vegetation

Methods:

There were twelve plots (number 1-12) located within the riparian zone. In each plot, there were 4 transects (numbered 1-4), and along each of which there were 4 1x1m subplots (indicated by the distance along the transect) which were sampled.

Four of the twelve plots initially contained little to no woody vegetation and were sampled as a benchmark or “control”. The remaining eight plots had woody vegetation removed, but four of those also were seeded with herbaceous plant species collected in nearby “open” or “prairie” habitat.

Sampling occurred in each of the 192 subplots. Seven cover classes were used to estimate species canopy coverage. 1 – 0.1% cover; 2 – 2-5% cover; 3 – 5-25% cover; 4 – 25-50% cover; 5 – 50-75% cover; 6 – 75-95% cover; 7 – 95-100% cover.

WSI01

Title: Long-term water (stream, groundwater, precipitation) stable isotope records at Konza Prairie

Purpose: Long-term oxygen and hydrogen stable isotope ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) records for precipitation, stream water, and groundwater at Konza Prairie Biological Station.

Date data commenced: 01/11/2010

Date data terminated: 12/30/2022

Methods:

Precipitation, stream, and groundwater sample collection: Precipitation samples for water chemistry and isotope analysis were collected in wet deposition collectors at KPBS headquarters as part of the National Atmospheric Deposition Program (NADP). Water from the collectors was collected every Tuesday morning (whenever water was available) following NADP protocols. Subsamples (1-2 mL) were then collected from each precipitation sample for isotopic analysis. Each sample therefore integrates the stable isotopic signature of any precipitation events over the previous seven days. Wet deposition collectors remain in a sealed closed position except during active precipitation events, eliminating the potential for evaporative isotopic enrichment of the precipitation samples. Samples are immediately frozen after collection. Stream samples were collected near the USGS weir locations on each watershed (N1B, N2B, N4D) three times per week in the mornings when water was available. Samples were collected from the middle of the stream and immediately frozen after collection. Groundwater samples from Edler Spring were also collected three times per week and immediately frozen after collection.

Stable isotope analyses: All water samples were analyzed for $\delta^{18}\text{O}$ and $\delta^2\text{H}$ using a Picarro WS-CRDS isotopic water analyzer at the Kansas State University Stable Isotope Mass Spectrometry Lab (SIMSL). Isotopic ratios were expressed in per mil (‰) relative to the international standard V-SMOW (Vienna Standard Mean Ocean Water). The long-term precision of water isotope analyses was assessed using three in-house standards to calculate a calibration curve, along with a laboratory working standard (n=16 per run) used for within-run drift correction. Assessed as standard deviation, the precision across and within runs was <0.3‰ for $\delta^2\text{H}$ and <0.15‰ for $\delta^{18}\text{O}$.