# Konza Prairie LTER

# Methods Manual

## March 2012

**Version 2012.2**

[1]Updated March 8, 2012

[2]Konza 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.

[3]*C* identifies changes made by version number

# Konza LTER Active Data Sets

**AGW01**

## Ground-Water Chemistry (AGW011)

**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.

**LOCATION OF SAMPLING STATIONS**

Thirty-five wells are located in the lower third of the N04d watershed, approximately along four linear transects perpendicular to the South Fork of Kings Creek.

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, and some are nested to include wells completed in alluvium/colluvium near the N04D drainage and in Permian-aged bedrock. Thin (1-2 meter) limestones alternating with thicker (2-4 meter) shales constitute the bedrock. Most bedrock wells sample the Morrill Limestone Member of the Beattie Limestone (stratigraphically lowest), two wells sample an unnamed 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 newer wells are about 12 m, 21 m, 27 m and 37 m deep, and are completed in the deepest unit accessed by the older wells. The sites comprise four transects running approximately east-west across the drainage, and occupy the lower one-third of the surface area of the watershed. The geology of the area is characterized by patchy, near-stream alluvium/colluvium that overlies bedrock. The limestones are fractured, and records of water levels in the wells show that in some parts of the watershed water levels are nearly constant, while in others they respond noticeably to meteoric precipitation.

**FREQUENCY OF SAMPLING**

Samples are collected every 4-6 weeks, as weather permits.

**VARIABLES MEASURED**

1) Depth to water (water level) in wells only.
2) Dissolved Na, K, Li, Ca, Mg, Sr, Ba, $SO_4$, Cl, F, $NO_3$-N, $HPO_4$-P, alkalinity Si, and B in all water samples with sufficient water.
3) Field pH in some well and stream samples

**FIELD METHODS**

Water level measurement

Depths to water and to the bottom of the wells are measured, after removing the PVC well

cap and allowing the well to "breathe" for several minutes, using a water level meter (e.g., Solinist 101, with flat polyethylene cable and stainless steel probe). Reference points are marked on the well casings. Reproducibility of measurements is on the order of 6 mm (0.02 feet).

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, rinsed (with ground water), 2-liter, low-density polyethylene (LDPE) jugs using a 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, 2-liter LDPE sampling jugs are rinsed with stream water and the rinse water discarded downstream. 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 0.45µ cartridge filters are used. For high suspended-solids samples, disposable high-capacity 0.45µ 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 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 east 10 seconds.

**LABORATORY METHODS**

Bottles are transferred to a ~7°C 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 $H_2SO_4$; 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.

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.

F, Cl, $NO_3$-N, $PO_4$-P, and $SO_4$ 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 $Na_2CO_3$ and 1.7 mM $NaHCO_3$ pumped at a rate oft 2 mL/min. The suppressor is continuously regenerated with distilled-deionzed 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.

ICP-OES (Instruments SA, Inc., JY-138Ultrace) 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).

**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 UP TO 2010**

From 1991 through 1993, all wells that contained water were sampled and water chemistry determined.

Jan 1991 - April 1994: Cations measured were Na, K, Ca, Mg by AAS

April 1994 - May 1997: Cations measured were Na, K, $NH_4$-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 Spectonix 2000 UV-VIS spectrometer

## Ground-Water Chemistry (AGW021)

### PURPOSE

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

### 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.

### VARIABLES MEASURED

Nitrate-N, ammonium-N, soluble reactive phosphate (SRP), total nitrogen, total phosphorus, dissolved organic carbon.

### 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 in Appendix F.

### LABORATORY METHODS

Upon return to 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 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 phosphorous nutrient determinations are analyzed on an OI Analytical Flow Solution IV (FSIV) instrument. Simultaneous determinations of nitrate and orthophosphate may be analyzed from a single aliquot by use of a stream splitter. In the same manner, total N and total P 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 ortho-phosphate or SRP, soluble reactive phosphate)** are run within one month of sample collection. As $NO_3$ and SRP are analyzed simultaneously, dual standards (both N and P) are utilized. Standards range from 0.5 to 200 µg/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.

**TN and TP** are analyzed on the FSIV analyzer ,following digestion, and can be done by trained student workers. Approximately 90 samples are run per session and usually during the summer. After digestion, a summation template is utilized to check organic and inorganic components.

Total N and total P concentrations values are determined in a two step process, utilizing a Total Persulfate digestion (modified from J.J. Ameel American Environmental Laboratory, October 1993) followed by $N0_3$ 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 $N0_3$ and SRP) range in concentration from 0 to 2000 µg/L $NO_3$ -N and 0 to 200 µg/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** are analyzed in batches of 50 using a Schimadzu T-5000 by a trained student worker. It is possible to do approximately three batches or 150 samples per week. 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 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.

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 yymmdd, 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 rundate 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.

**WORKFLOW TO ARCHIVE**

As data are collected throughout the year, they will be added by the lab student worker or Lab RA into the appropriate excel spreadsheet. When all the data have been analyzed for a year, the data entry student worker will copy and paste DOC data and/or TN/TP data to the working excel spreadsheet . The student data Entry person will confirm TN and TP data by a summation template. Any values exceeding summations will be highlighted for review by Lab RA. Approved TN-TP values will be inserted into Master Excel spreadsheets. The student data entry person will print this spreadsheet as hard copy to be filed in the data entry room for review and corrections by the Lab RA. After corrections for the entire year are received back from the Lab RA, the data entry person will make the corrections and return to the Lab RA for final review and sign off. The PI in charge of the AGW data set will then review the final data and sign off. The data will then be ready for kedit formatting and archive by the Information Manager.

**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.

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; the 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 Enviromentals in Manhattan) and cheap kitty litter.

## NADP Wetfall (ANA01)

**PURPOSE**

Collect wetfall and precipitation for analysis of atmospheric input of nutrients to tallgrass prairie.

**LOCATION OF SAMPLING STATION**

Headquarters weather station (grid C-16).

**FREQUENCY OF SAMPLING**

Weekly, continuous from August 17, 1982.

**VARIABLES MEASURED – KSU laboratory**

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

**VARIABLES MEASURED – Central Analytical Laboratory (CAL), Illinois State Water Survey, Champaign IL**

1) Conductivity of precipitation (μS/cm).
2) pH of precipitation.
3) Concentrations of the following (mg/1): $SO_4$, $NO_3$, $NH_4$, 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 aon 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. An example of the field form is shown in Appendix F. 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. An example of the data output by the Central Analytical Laboratory is shown in Fig. 4. 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. A clean kimwipe and distilled water should be used. 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 raingages, and observe the operator to determine necessary changes in operations. Last site visit was October 21, 2010.

**SUMMARY OF ALL CHANGES UP TO 1993**

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 will be 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 raingage at headquarters weather station.

## Prairie Precipitation (APT011)

**PURPOSE**

Monitor rainfall in tallgrass prairie on a long term basis.

**LOCATION OF SAMPLING STATIONS** (see Appendix M for map)

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

Belfort Weighing Raingauges:

| | |
|---|---|
| Headquarters 2 (C-16) | 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 |

**FREQUENCY OF SAMPLING**

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

**VARIABLES MEASURED**

Daily amounts of precipitation (mm)

**METHODS**

Precipitation is measured at headquarters by an Ott Pluvio² rainguage (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.

Previous to this instrument two Belfort weighing raingauges, 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 raingauges 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 raingauges are not operated during the winter months (November-March).

Routine Maintenance:

Charts on all Belfort weighing raingauges require changing each week. Catch buckets in the raingauges are emptied at the time of chart changing except when the headquarters raingauge is winterized with antifreeze (see Belfort manual for details). Clock mechanisms require rewinding each week and pens must be refilled with ink. The prairie raingauges 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 APT011.

The Ott Pluvio$^2$ 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 Pluvio$^2$ manual for details. SAS formats data and generates

daily data and 15 minute data from the Ott Pluvio$^2$ rain gauge.

**CHANGES MADE SINCE INCEPTION**

000719: N04D- Upland raingage was accidentally destroyed by KPBS personnel. RG was moved a short distance from original site and located inside bison pasture on 010815.

1987: When bison where introduced to the Konza wire paneling was placed around N02B, N04D-Up, N04D-Low, and N01B.

2001: 020A raingage now identified as R01A raingage – watershed name change.

March 2010: Additional Ott Pluvio$^2$ rain gage was installed at the Konza HQ site (continuous remote monitoring module).

April 01, 2011: HQ1 and HQ2 are discontinued. Precipitation values now reported from Ott Pluvio² raingage at Konza HQ site.

## Kings Creek Stream Hydrology and Chemical Analysis (ASD01)

**PURPOSE**

Periodicity and volume of stream flow and transport of inorganic materials in surface waters of Kings Creek. This is USGS data available at waterdata**.**usgs**.gov/**

**LOCATION OF SAMPLING STATION**

Lower Kings Creek (grid H-15).

**FREQUENCY OF SAMPLING and VARIABLES MEASURED**

15 minute interval: Stream discharge

Periodic:

| | |
|---|---|
| Alkalinity | Turbidity (Jackson units) |
| Bicarbonate | Nitrogen (total organic, total, $NH_4$, dissolved, suspended, |
| Calcium | $NO_2 + NO_3$) |
| Chloride | 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, Cadium, 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. U.S.G.S. Circular 460-E.

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

**FORM OF DATA OUTPUT**

We receive stream discharge (cfs) data at 15 minute interval continuous records. Discharge

data is stored on computer tape. We do not have chemistry data at this time.

**ASD02-6**

**Stream Discharge (ASD02, ASD04, ASD05, ASD06)**

**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).

**LOCATION OF SAMPLING STATIONS**

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

**FREQUENCY OF SAMPLING AND VARIABLES MEASURED**

Stream gage height is recorded every five minutes on the CR-21X datalogger (Campbell Scientific Co.). Each record also includes Julian day and time. Temperature is recorded hourly (see data set AWT02). Data are dumped at approximately one to two week intervals from the CR-21X memory to cassette tape (up to about 2000) or laptop computer (to present). Data are copied onto the network as soon as they are returned to Bushnell Hall (so 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. Detailed instructions for programming the CR-21X, dumping data to computer, and reading the Campbell files into the microcomputer are available in Appendix P.

**METHODS**

Gage height is sensed by pressure transducers (Druck Model PDCR 10/D) and recorded on the CR-21X. Conversion to stream discharge requires:

1) Correction of measured gage height to actual gage height using direct measurements of stage made at least weekly at reference points at each flume, see APPENDIX P for instructions on how to correct the measured gage height.

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. A log book with information of each data dump and current condition of the stream is located in Bushnell Rm 205 in the data entry cabinet.

Detailed instructions for retrieving stream data, entering time and date, changing batteries,

etc. are located in Appendix P.

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 now 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. Stage data can be converted to discharge by using the equations above.

## Soil Moisture (ASM01)

### PURPOSE

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

### 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 Appendix M.

### 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 $20^{o}$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 200cm. 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 x1.5 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.
Current data sheet is available in Appendix F.

### 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 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 <u>either</u> 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 <u>below</u> the standardized height. Both N04D sites were cut in May 2004 due to bison damage.

| | | 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 |

2010: September 3, R01A was discontinued due to damage when cutting.

Fall 2015: No soil moisture readings from August through November 2015. Troxler machines no longer working. A new machine has been ordered.

Dec. 2015: Soil moisture readings done with new machine. There are some differences from the old machine. 1. The new probe is slightly longer, and 2. There are only 7 depth markers. Therefore, 200cm depths will no longer be done. The new machine reports in g/cc. All data sheet measurements will be multiplied by 1000 to maintain the historic use of $kg/m^3$

## Stream Suspended Solids (ASS01)

### 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 (NO2B) 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.

### 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.

### VARIABLES 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 $^{0}$C for a minimum of 24-hours before further processing.

### LAB METHODS

Samples are filtered onto prepared glass microfiber filters (pre combusted in a muffle furnace at 500$^{o}$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$^{o}$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$^{o}$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 NO2B
ASS012—data for watershed NO4D

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

## Stream Water Quality (ASW01)

### 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.

### 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. ASW01 Protocols can be found in Appendix P.

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)

***C*-V2012.1**

## Meteorological Measurements (AWE011, AWE012)

**PURPOSE**

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

**LOCATION OF SAMPLING STATIONS**

Headquarters weather station (grid C-16).

**FREQUENCY OF SAMPLING**

Continuous sampling at headquarters weather station.

**VARIABLES MEASURED**

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

**METHODS**

A Campbell Scientific (CR-10) data logger continuously monitors air temperature, relative humidity, solar radiation, wind speed, soil temperature, precipitation, and wind direction. A microprocessor in the CR-10 manipulates the raw data and outputs the average air temperature, soil temperature, relative humidity, wind speed, solar radiation, total precipitation, and the sampled wind direction on 5 minute and hourly intervals. Every 24 hours daily maximum, minimum, and average air temperatures, soil temperatures, relative humidity, and solar radiation are output. The CR-10 data is accessed every 15 minutes via wireless internet. Campbell Scientifics' Loggernet and SAS software format and output data to AWE011 (hourly) and AWE012 (daily) final storage locations and prepare graphics for web viewing.

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
- Check tipping bucket rain gage for debris

Biyearly maintenance includes :

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

**CHANGES MADE SINCE INCEPTION**

- Program execution interval was changed from 60 seconds to 10 on 7/17/00. This change could significantly influence values reported for max wind speed. Caution should be used when comparing max wind speeds across this date.
- Solar radiation collected prior to 7/19/00 is recorded in Langleys.
- 7/14/00 maximum daily wind speed location was changed to average wind speed.
- Hourly ppt. not precise and removed after 1/1/00. All AWE01 ppt data is collected via tipping bucket. APT01 data should be used for more accurate precipitation values.
- Soil Temperature data unavailable from 2001 to August 12, 2008 and December 7, 2009 to May 21, 2010.

***C*-V2011.2**

## Belowground Plant Species Composition (BGPVC)

### PURPOSE

To determine the canopy coverage of all plant species and total species coverage, richness, and diversity.

### LOCATIONS OF SAMPLING STATIONS

LTER belowground study plots.

### SAMPLING HISTORY

In 1989, sampling was done once in early July after mowing using one 10 $m^2$ 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 $m^2$ plot sizes. In 2005 sampling was reduced to one time in late July, and that was continued in 2010.

### FREQUENCY OF SAMPLING

See above.

### VARIABLES MEASURED

Species presence and canopy coverage class for each species . Sample data sheets are in Appendix F.

### METHODS

To assess plant species composition all plant species in a 5 $m^2$ 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:

| Class | Canopy 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% |

### 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.

## Grasshoppers (CGR02)

**PURPOSE**

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

**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.

**VARIABLES 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 $180^{o}$ 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-$40^{o}$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.

Current data sheet available in Appendix F. Maps of all grasshopper sites available in Appendix M.

**SUMMARY OF 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 weather 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 ± 1.8°F ; Wind speed .8 to 89 mph Accuracy ±3%

*C*-V2011.3, V2011.4

## Survey of Prairie Chicken Leks (CPC01)

**PURPOSE**

Locate and enumerate the number of lekking males.

**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.

**VARIABLES 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 UP TO 2010**

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.

## Small Mammals (CSM01)

### 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.

### 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).

### VARIABLES 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 in Appendix F.

### 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 animals to indicate that that individuals 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 UP TO 2010**

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 $\leq 1$ 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 were 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.

## Small Mammals (CSM04)

### 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.

### 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).

### VARIABLES 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 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 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 animals to indicate that that individuals 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 $\leq$ 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 UP TO 2010**

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.

## Small Mammals (CSM05)

### 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.

### 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).

### VARIABLES 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 animals 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 $\leq$ 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 UP TO 2010**

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 an 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.

## Bulk Precipitation Chemistry (NBP01)

### PURPOSE

To measure the chemical composition of bulk precipitation inputs.

### 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 raingauges 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.

### VARIABLES MEASURED

1.) Amount of precipitation (mm)
2.) concentration of $NO_3$-N in each sample
3.) Using volume-weighted monthly composite from each site: Measured concentrations of $NH_4$-N, soluble reactive phosphate (SRP), and total N and total P.

### METHODS

Precipitation amounts (mm) are measured at each site using a standard raingage. 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 sample is analyzed for $NO_3$-N. Monthly a volume weighted composite is made for each site and subsequently analyzed for $NH_4$-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. Simultaneous determinations of nitrate (single events) and SRP (monthly composition) may be analyzed from a single aliquot by use of a stream splitter. In the same manner, total N and total P 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 the instrument's computer and also transferred to offsite backup data storage.

**Inorganic Nitrogen (N) and Phosphorous (P) (nitrate, ammonium, and ortho-phosphate or SRP, soluble reactive phosphate)** are run within one month of sample collection. As $NO_3$ and SRP are analyzed simultaneously, dual standards (both N & P) are utilized.

Concentrations range from 0.5 to 250 µg/L $NO_3$-N and 0.5 to 150 µg/L SRP. Ammonium standards range from 0.5 to 200 µg/L $NH_4$-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. Ameel American Environmental Laboratory, October 1993), followed by simultaneous determinations of nitrate and SRP on FSIV instrument. In general, a series of 10 duplicated standard solutions, a digestion recovery standard (i.e. Spike solution: ATP + urea), 4 spiked samples, an oxidizing reagent blank and 88 samples comprise each digestion run. Dual standards (both $NO_3$ and SRP) are used, ranging in concentrations from 0 to 2000 µg/L $NO_3$-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 UP TO 2010**

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.

Samples collected in 1982-1983 were analyzed according to the methods outlined in Appendix A of the 1983 LTER Methods Manual. In 1984, methods of chemical analysis were modified. Samples collected in 1984 to present were analyzed according to the methods given in Appendix A of the 1984 LTER Methods Manual.

In 2001, 001C watershed was renamed to R20B.

## Physical and Chemical Characteristics of Soil (NSC01)

### 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.

### LOCATION OF SAMPLING STATIONS

Soils are sampled along the LTER vegetation transects.

### 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.

### VARIABLES 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, $NH_4^+$-N, and $NO_3^-$-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$^{o}$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 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.

## Stream Water Chemistry (NWC01)

**PURPOSE**

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

**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 flune: (N-21)
N04D flume: (L-22)
N20B flume: (N-22)
Elder 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

**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.

**VARIABLES MEASURED**

$NO_3^-$-N + $NO_2^-$-N, $NH_4^+$-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 (N01B, N02B, N04D, and N20B only).

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.

## Above Ground Biomass (PAB0_1)

**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.

**LOCATIONS 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.

**VARIABLES 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 $m^2$ (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$^{o}$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.

**LAB 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$^{o}$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.

Current data sheet can be found in Appendix F.

**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$^{o}$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 ($H_2SO_4$) 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$^{o}$ 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 herbaceous* (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.

## Above Ground Biomass on Belowground Plots (PBB01)

**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).

**LOCATION**

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.

Current data sheet available in Appendix F.

Map available in Appendix M.

**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 Kjedahl procedure and the solution analyzed for total-N and total-P by automated calorimetric analysis. (PBB012)

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.

## Patch Burn-Grazing (PBG01)

### PURPOSE

To determine long-term changes in canopy cover, frequency, richness, and diversity in pastures that are rotationally burned and seasonally grazed by cows.

### 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.

### VARIABLES MEASURED

Canopy cover of all vascular plant species in each plot are estimated.

### 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-$m^2$ circular area surrounding 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% |

### FORM OF DATA OUTPUT

Raw data contains the cover class value for each species detected in the plot. A value of 1 to 7 in plots a1-d5 indicates the estimated cover class value for the species. A blank value indicates that the plant was not observed 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.

## Primary Production in Grazing Exclosures (PEB01)

**PURPOSE**

To determine long-term effects of bison grazing on aboveground primary production.

**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)

**VARIABLES 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. See PEB01 illustration 1 in Appendix M . The "grazed" sections were moved in late spring of 1997, 2004 and 2010.

Sampling methods are identical to PAB01 except five 0.1 $m^2$ 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$^{o}$C and then fully sorted to live (grass), forb, woody and p.dead components. The samples are then dried again at 60$^{o}$C and weighed. Samples are not kept for further analysis.

Current data sheet can be found in Appendix F.

Maps available in Appendix M.

**SUMMARY OF CHANGES**

ORIGINAL METHODS: The "grazed" section used to be temporary. It was erected adjacent to the each permanently ungrazed exclosure at the beginning of the growing season and remained in position until peak biomass occurred. The temporary grazed exclosure 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 exclosures 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 decide 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 in Appendix M.

## Gallery Forest Litterfall (PGL01)

### PURPOSE

To measure annual inputs of macro particulates (particles greater than 1 $mm^2$ 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.

### 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 (PGLO1 Figure 1 available in Appendix M.) 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 x 30. 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 (PGL01 Figure2 available in Appendix M.)

### 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).

### VARIABLES MEARSURED

Total deposition of litter (grams of dry weight/0.25 $m^2$) 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 $m^2$) 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. Most recent design attached in Appendix P.

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 MEARSURED (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 $m^2$) 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 (available in Appendix P) 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 assesses 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.

## Seed Production and Stem Densities of Grasses (PRE02)

### PURPOSE

To estimate seed reproduction, flowering stem mass, height, and population densities of three dominant prairie grasses: Andropogon gerardii (ANGE), Sorgastrum nutans (SONU), and Schizachyrium scoparium (ANSC) in the Konza Prairie LTER watersheds.

### 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 (see PVC maps in Appendix M.) 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).

### VARIABLES 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 $m^2$),1982-present = **PRE022**
4. Weight of flowering stems (g per $m^2$),1982-present = **PRE022**
5. 

### 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.
Current data sheet can be found in Appendix F.

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 0.25$m^2$ 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 $m^2$) and the mean biomass of flowering stem (g per $m^2$) are calculated for each species.
Current data sheet can be found in Appendix F.

**SUMMARY OF 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 $10m^2$ 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 $m^2$) 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), Sorgastrum 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.

# Plant Species Composition (PVC02)

## PURPOSE

To determine long-term changes in canopy cover, frequency, richness, and diversity in watersheds from different burn treatments in grazed and ungrazed watersheds.

## 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 in Appendix M.

## 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, Ca, Cb, Cc, Cd, Sa, Sb, Sc, and Texas Hog. Sampling in the eight seasonally burned watersheds began in 1994 and sampling in the Shane and Cattle Units began in 2008. 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 mid-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.

## VARIABLES 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-$m^2$ 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% |

**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 CHANGES**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cattle | pasture | c03a | was | called | Ca | in | 2008 | & | 2009 |
| Cattle | pasture | c03b | was | called | Cb | in | 2008 | & | 2009 |
| Cattle | pasture | c03c | was | called | Cc | in | 2008 | & | 2009 |
| Cattle | pasture | c01a | was | called | Cd | in | 2008 | & | 2009 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ca | had | only | two | transects | in | 2008 | (a | & | b). |
| Cc | had | only | two | transects | in | 2008 | (c | & | d). |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shane | pasture | c3sa | was | called | Sa | in | 2008 | & | 2009 |
| Shane | pasture | c3sb | was | called | Sb | in | 2008 | & | 2009 |
| Shane | pasture | c3sc | was | called | Sc | in | 2008 | & | 2009 |

Pasture c01b was called Texas Hog (thp) in 2009.

Mapping of Woody Plants (PWV01)

**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.

**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.

**VARIABLES MEASURED**

Location of each individual tree, shrub and patch of shrubs 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.

## Irrigation Transect (WAT01)

**PURPOSE**

To assess the long-term response of selected vegetational 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.

**LOCATION OF SAMPLING**

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 (Map available in Appendix F).

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 compositions 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. Species composition is sampled once each season in late June. Soil chemistry is sampled at five-year intervals. All plots are sampled for species composition once each year in late July.

**VARIABLES 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 are 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 then 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 raingauges 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 raingauge 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 raingauges 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; it's 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 toclose 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 raingauges 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 raingauges 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. The expected typical gradient of additional water as a percent of the amount 2 m from the line of sprinklers is shown in Appendix M.

Aboveground biomass (WAT013):

Methods are identical to those in data set PAB011 except six 0.1 $m^2$ 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 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 Appendix F.

Plant reproductive effort (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 $m^2$ 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 sheetes. These "spots" did not impact collections: generally these spots are less than 1 ft in diameter.

Current (2009) data sheet available in Appendix F.

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.

# Konza LTER Inactive Data Sets

**AWT01**

## Water Temperature (AWT01)

**PURPOSE**

To monitor water temperature in streams on a routine basis. Such data is essential for proper interpretation of many stream phenomena and questions related to global warming. Baseline data prior to implementing the burning or grazing protocols in Kings Creek south branch catchments will be used to assess effects of these treatments on stream temperature. The relationship between hydrologic patterns and water temperature can also be examined.

**LOCATION OF SAMPLING STATIONS**

Routine measurements of temperature are made near the V-notch of each of the four concrete flumes in N04B, N01B, N02B, and N20B. Any other location which has routine temperature data (especially if the study lasts at least one year) should be incorporated into this data set.

**FREQUENCY OF SAMPLING AND VARIABLES MEASURED**

Temperature ($^{o}$C) is measured at least weekly.

**METHODS**

Standard water thermometers capable of 0.2$^{o}$C precision are used. Measurements for each flume are recorded on the monthly field data sheets at each flume.

**FORM OF DATA OUTPUT**

Data is transcribed from the monthly field data sheets at each flume (or from any other location) onto other data sheets prior to data entry.

Note: Data set AWT01 is for the discontinuous water temperature measurements. These were begun on a routine basis in 1985 at each flume. Beginning in 1986, continuous (hourly) measurements using thermocouples have been made and recorded on the same CR-21X data loggers used for recording gage height (see data set ASD02). Point measurements (AWT01) will be continued for verification and backup of the thermocouple measurements. Data from other projects where temperatures are measured routinely at fixed locations should be archived as part of this data set.

# Water Temperature (AWT02)

## 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.

## 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 AND VARIABLES MEASURED

Temperature ($^{o}$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.

## Belowground Plots: Mycorrhizae (BMS01)

**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.

**LOCATION OF SAMPLING STATIONS**

LTER belowground study plots - sampled every 5 years.

**VARIABLES 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 propogules 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.

## Above Ground Arthropods (CAA01)

06/01/81 to 09/01/81

**PURPOSE**

Determine species presence and numbers of other arthropods on the Konza Prairie LTER watersheds.

**LOCATION OF SAMPLING STATIONS**

Same as for grasshoppers data set (CGR02).

**FREQUENCY OF SAMPLING**

Same as for grasshoppers data set (CGR02).

**METHODS**

Above ground arthropods were removed and counted from the same sweep samples taken for grasshoppers (see data set CGR02). Only those individuals greater than 1 mm in length are counted. Not all samples from all sites will be sorted and counted each year; how much is sorted will depend on how much help is available.

## Bird Check List (CBC01)

**PURPOSE**

To determine bird species phenology of occurrence.

**LOCATION OF SAMPLING**

Konza Prairie - entire area.

**FREQUENCY OF SAMPLING**

Continuous.

**VARIABLES 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.

Bird Dates (CBD01)

**PURPOSE**

Date of observation of all birds seen on Konza Prairie.

**LOCATION OF SAMPLING**

Konza Prairie - entire area.

**FREQUENCY OF SAMPLING**

Continuous.

**VARIABLES MEASURED**

Species and date of observation.

**METHODS**

Direct observation.

**FORM OF DATA OUTPUT**

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

# Bird Nest (CBN01)

## PURPOSE

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

## LOCATION OF SAMPLING

Konza Prairie - entire area.

## FREQUENCY OF SAMPLING

Continuous.

## VARIABLES MEASURED

Nest contents.

## METHODS

Direct observation.

## FORM OF DATA OUTPUT

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

## Birds (CBP01)

### PURPOSE

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

### 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: N0lB (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.

### VARIABLES 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.

?: 004d became SA and transect was dropped.

## Gall Insect Sampling (CGP01)

### 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.

### LOCATION OF SAMPLING STATIONS

Sampling is done in watersheds 001A, 001B, 001C, 001D, 004A, 004B, 004C, 004D, $004F_s$, 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 into the winter months, many of the stems may senesce and lodge resulting in increased sampling time and effort required.

### VARIABLES 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 eliptical 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.

## Small Mammals (CSM02)

### 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).

### LOCATION OF SAMPLING STATIONS

Ungrazed, gallery forest - N01A (G), N04B (XP)
Ungrazed, 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).

### VARIABLES 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 in Appendix F.

### 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 $\geq$ 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 ($\approx$ 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 ($\leq$ 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 $\leq$ 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, 1985, 1986 and 1987, 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.

## Small Mammals (CSM03)

### 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).

### 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).

### VARIABLES 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 in appendix.

### 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 ($\approx$ 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 ($\leq$ 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 $\leq$ 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.

## Small Mammals (CSM06)

**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).

**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).

**VARIABLES 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.

## Soil Chemical Properties: Belowground Studies (NBC01)

### 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.

### 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.

### VARIABLES MEASURED

Unless otherwise noted, the methods 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) found in APPENDIX D.

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 $NH_4OAc$ 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 $NH_4^+$ 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.

## Soil Water Chemistry from Lysimeters on Belowground Plots (NBS01)

**PURPOSE**

To measure $NO_3$-N, $NH_4$-N, $PO_4$-P and organic N and P in soil water from control and N fertilizer plots in Belowground Studies Plots.

**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 -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.

**VARIABLES MEASURED**

Volume of soil solution was recorded for each lysimeter and the samples were returned to the laboratory for analysis of $NO_3$-N, $NH_4$-N, $PO_4$-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 (Appendix A).

**Prairie Litterfall (NPL01)**
06/09/81 to 12/11/90

## 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.

## 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.

## VARIABLES MEASURED

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

## METHODS

At each site, six or eight 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 were in place.

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

Collected material was dried to constant weight at 70°C. Nitrogen and phosphorus content were determined by digestion in $H_2SO_4$ followed by calorimetric measurements using a Technicon Autoanalyzer. Further details are provided in Appendix A.

**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.

**Soil Water Nitrogen: Lysimeter Studies (NSW01)**

03/01/82 to 12/1/90

## PURPOSE

To measure $NO_3$, $NH_4$ and organic-N in soil water collected at two depths (20 cm and 80 cm) using porous cup lysimeters.

## 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 to 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.

## VARIABLES MEASURED

Volume of soil solution was recorded for each lysimeter and the samples were returned to the laboratory for analysis of $NO_3$ 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 $H_2O$ 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 (Appendix A).

**SUMMARY OF ALL CHANGES**

Methods of chemical analysis were modified in 1984. Samples collected in 1982-83 were analyzed according to the methods outlined in Appendix A of the 1983 LTER Methods Manual. Samples collected

# Throughfall Chemistry (NTF01)

## 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.

## 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 at 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 1985. 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, bu 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 raingauges 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.

## VARIABLES MEASURED

Total sample volume of throughfall or precipitation collected is recorded for each sample, and concentrations of $N0_3^-$ 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 variable 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. Laboratory procedures for $NO_3^-$, $NH_4^+$, $PO_4^-$, and organic -N and -P are described in Appendix A.

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 raingauges 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 UP TO 1993**

In 1982, throughfall was measured on four watersheds (001D, 001C, N01D, and N04D). Each site had one raingauge, 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. And additional site for collection of bulk precipitation at headquarters was added in April 1985. Bulk precipitation an 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 outlined in Appendix A of the 1983 LTER Methods Manual. In 1984, methods of chemical analysis were modified. Samples collected in 1984 to present were analyzed according to the methods given in Appendix A of the 1984 LTER Methods Manual.

# Microbial Biomass (OMB01)

## PURPOSE

Monitor long-term changes in microbial biomass due to the effect of annual burning, mowing and nitrogen and phosphorus fertilization.

## LOCATION OF SAMPLING STATION

HQC

## FREQUENCY OF SAMPLING

Three times a year for microbial biomass and inorganic-N: pre-burn (April), post-burn (June), and fall (October).

## VARIABLES 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 then 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$^{o}$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$^{o}$C. At the end of the incubation period, the $CO_2$-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$^{o}$C with an He carrier gas flow rate of 14 mL $minute^{-1}$. After measuring $CO_2$-C, 100 mL of 1*M* 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 $NH_4^+$-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).

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 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 $kg^{-1}$ 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 1*M* 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 (10μm) 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 $kg^{-1}$ 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.

## Below Ground Plant Biomass on Belowground Plots (PBB02)

### 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.

### LOCATION OF SAMPLING STATION

HQC

### FREQUENCY OF SAMPLING

Once every five years in August or September.

### VARIABLES MEASURED

1) Root biomass sorted by live, dead, and 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 $60^{o}$C. The dried material is then ground to pass a 2 mm screen and acid digested by the Kjedahl procedure. The solution is then analyzed for total-N and total-P by automated calorimetric analysis.

**Flowering Stem Heights, Density, and Production on the LTER Belowground Plots (PFS01)**

6/1/86 to 9/1/92

## 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. scoparious) and Indian grass (Sorghastrum nutans), and total vegetation production.

## 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.

## VARIABLES 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 into 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.

**Plant Phenology (PPH01)**
06/13/81 to 10/31/88

**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.

**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 $C_3$ and $C_4$ 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 |
|---|---|---|---|---|---|
| Andropogon gerardii, big bluestem | + | + | + | + | |
| Andropogon scoparius, little bluestem | + | + | + | + | |
| Sorghastrum nutans, indiangrass | + | + | + | + | |
| Boutelous curtipendula, sideoats grama | + | + | + | + | |
| Panicum virgatum, switchgrass | | | + | + | |
| Dicanthelium oligosanthes var. scribnerianum, scribner panicum | + | + | + | + | |
| Sporobolus asper var. asper, tall dropseed | + | + | | | |
| Sporobolus heterolepis, prairie dropseed | | | | | + |
| Poa pratensis, Kentucky bluegrass | | + | | | |
| Carex gravida var. lunelliana, heavy sedge | + | + | + | + | |
| Carex meadii, Mead's sedge | + | + | + | + | |
| Amorpha canescens, leadplant | | | + | + | |
| Astragalus crassicarpus var. crassicarpus, groundplum milkvetch | | | | | + |
| Dalea purpurea var. purpurea, purple prairieclover | | | | | + |
| Schrankia nuttalli, catclaw sensitivebriar | | | | | + |
| Aster ericoides, heath aster | + | + | + | + | |
| Lomatium foeniculaceum var. daucifolium, carrotleaf lomatium | + | + | | | |
| Salvia pitcheri, pitcher sage | + | + | | | |
| Liatris punctata, dotted gayfeather | + | + | | | |
| Solidago missouriensis var. fasciculata, Missouri goldenrod | + | + | + | + | |
| Cornus drummondii, roughleaf dogwood | | | | | + |

| | |
|---|---|
| Baptisia australis var. minor, blue wildindigo | In one site intermixed or close together |
| Baptisia bracteata var. glabrescens, plains wildindigo | In one site intermixed or close together |
| Tripsacum dactyloides, eastern gamagrass | One site NW of headquarters |
| Rhus glabra, smooth sumac | One site |
| Agropyron smithii, western wheatgrass | One site, unburned |
| Populus deltoides subsp. monilifera, eastern cottonwood | Kings Creek forest |
| Celtis occidentalis, common hackberry | Kings Creek forest |
| Quercus muehlenbergii, chinquapin oak | Kings Creek forest |

**FREQUENCY OF SAMPLING**

Approximately weekly during the growing season, typically early April to late November. Observations began in mid-June in 1981 and ended on October 31, 1988.

**VARIABLES MEASURED**

Dates of the following stages were recorded:

1) Initiation of 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 were grouped into three categories: 0-5%, 5-20%, and greater than 20%.

**Root Windows (PRW01)**
02/01/84 to 12/31/89

## PURPOSE

To measure root lengths, new growth and decomposition on annually burned and unburned prairie.

## 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 into 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 above 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.

## VARIABLES 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 same 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 glare on the Plexiglas. Insects and poison ivy have distracted from the enjoyment of this exercise.

## 001D - 020B Biomass Transect (PTN01)

### 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.

### LOCATION OF SAMPLING STATIONS

Cross-watershed transects were established in two watershed 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 measurement of 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 for 1992). Soil moisture was sampled approximately every two weeks during the growing season of 1993-1996. **Discontinued September 1996**.

### VARIABLES MEASURED

Total aboveground biomass per unit area and associated sub-categories as in PAB01. Soil moisture was measured by Time Domain Reflectrometry (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 0.1 $m^2$ 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.

## Mycorrhizal Populations (XMS01)

07/01/86 to 09/01/86

### PURPOSE

To determine mycorrhizal fungus species composition and number in each of the LTER sampling sites. Percentage mycorrhizal colonization and colonization intensity of sampled plant roots will also be determined.

### LOCATION OF SAMPLING STATIONS

Revised vegetation transects - sampled 1 - 2 times/year.

### VARIABLES 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 and colonization intensity 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 and colonization intensity (Kormanik and McGraw, 1980).

Daniels, B. A., and H. D. Skipper (1982). Methods for the recovery and quantitative estimation of propogules 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.

## Nematode Sampling and Extraction (XNS01)

### PURPOSE

To monitor nematode densities and trophic composition at the Konza Prairie LTER belowground study plots.

### LOCATION OF SAMPLING STATIONS

The belowground study plots are located south of the aboveground burn treatment plots, (grids B-16 and C-16).

### SAMPLING FREQUENCY

Soil cores are collected in the fall of every other year, beginning in May, 1987. Sampling will be reduced to once per five years after the first few years of the study.

### VARIABLES MEASURED

1) Nematode densities
2) Trophic composition

### METHODS

All plots will be sampled with a 5 cm diameter coring tool to a depth of 20 cm. The Christie-Perry Technique, as modified by Dr. C. C. Russell at Oklahoma State University, will be used to extract the nematodes from a composite sample obtained from four soil cores for each treatment. The following is a brief summary of the steps in the extraction procedure:

1) A 100 $cm^3$ soil sample is suspended in 3 L of $H_2O$ and allowed to settle for 90 seconds.
2) The soil/$H_2O$ solution is poured through a 15 mesh sieve nested over a 400 mesh sieve.
3) The screenings from the 400 mesh screen are washed onto two layers of Scotties brand tissue which have been supported in a 4 inch diameter pot by a wire screen. The $H_2O$ level in the pot should just cover the sample.
4) After 24 hours, nematodes that have migrated through the tissue are collected from the bottom of the pot by decanting the $H_2O$ to a volume of 40-50 ml.