Long Term Ecological Research

in

Tallgrass Prairie

A proposal to
The National Science Foundation
for funds to support
long term measurements on

The Konza Prairie Research Natural Area

Abstract

This proposal emphasizes that the Konza Prairie Research Natural Area, an experimental ecological reserve near Manhattan Kansas, represents an ecosystem type (tallgrass or bluestem prairie) that should be represented in any network of long term ecological research sites. Site related research with long term goals will generate a data base that will sharpen the interpretation of short term experimental investigations of ecological phenomena. This is so, in part, because it also identifies ecological phenomena that occur on time scales of decades or longer. KPRNA was acquired and set aside by The Nature Conservancy and is managed by Kansas State University for the purpose of long term research.

The measurements we propose to make, some of which have been underway since 1972, are chosen to represent dominant components of the prairie ecosystem and a range of life history patterns of the prairie biota. The outline of the LTER program for KPRNA is found on page 28.

The initial five year period of this program is devoted to developing protocols, initiating the remainder of the measurements, and training the technical staff that will continue the data collection.

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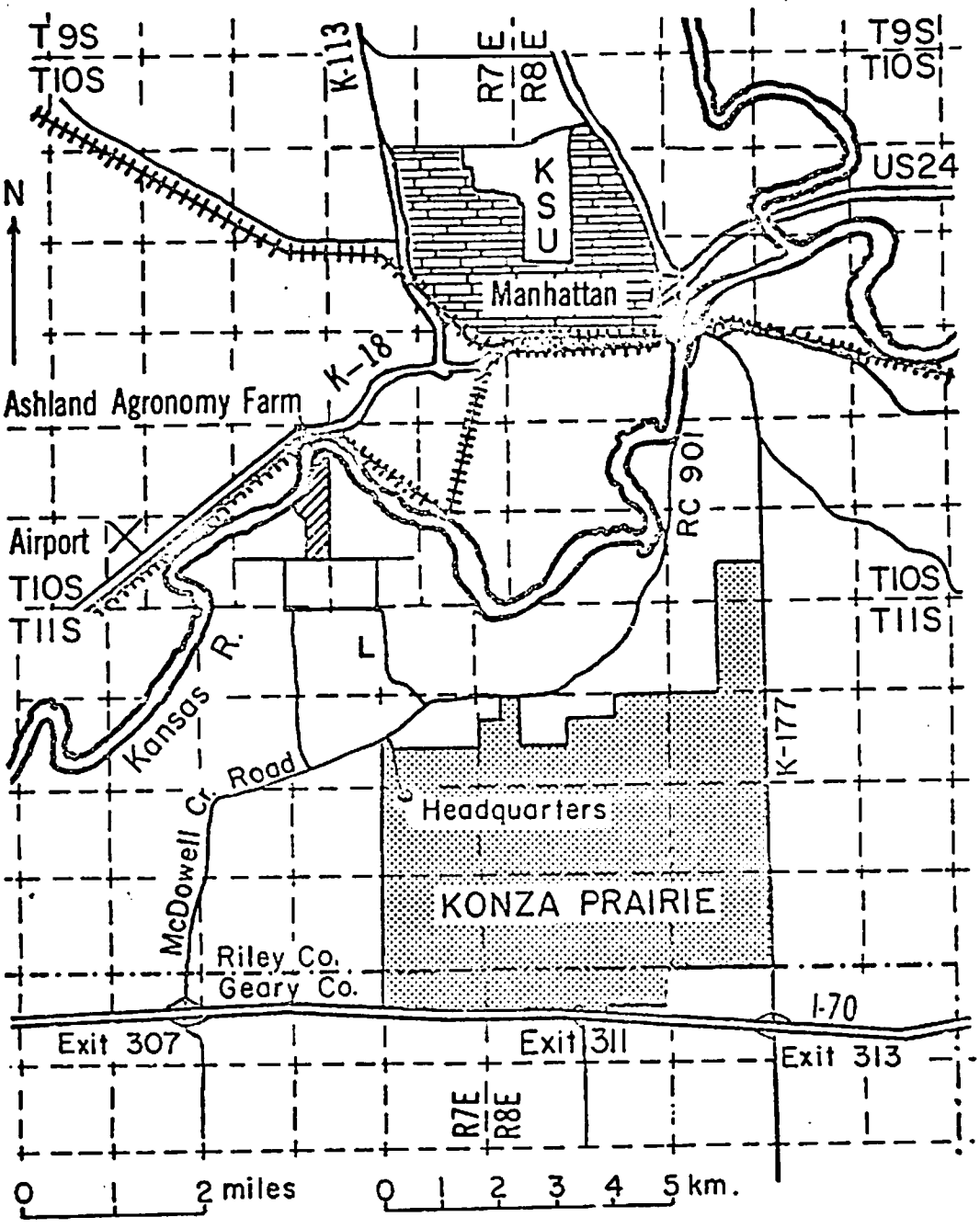

Fig 1. Juxtaposition of KPRNA to the city of Manhattan and Kansas State University. Global coordinates of the headquarters are 96° 36' 15" W and 39° 06'N.

I. Introduction

The Konza Prairie Research Natural Area (KPRNA) was sought, identified, and in the period 1971-1979 was purchased and set aside in perpetuity for the precise purpose of long term ecological research by scientists at Kansas State University and others. KPRNA is a 3486 hectare tract of bluestem or tallgrass prairie and associated gallery forest located about 10 km south of Kansas State University in Manhattan, Kansas (Fig. 1).

In 1976 a series of meetings and workshops began at Woods Hole, Massachusetts, to discuss the needs and develop the rationale and objectives of a national program of long term ecological research (Anon. 1977b, 1978, 1979a). One of the outcomes of these sessions has been the welcome response of the National Science Foundation in the form of a program to which we now apply for financial support to initiate our program in concert with others who have similar objectives. The near coincidence of KPRNA's establishment with the initiation of this program is fortuitous in that Kansas State University's committment and direction has, to this point, been strong but independent. The two efforts are related philosophically, however, as a common response to similar scientific needs and the general urgency to set aside examples of native landscape for long term ecological research.

This proposal emphasizes that: (1) The Konza Prairie Research Natural Area is the premier tallgrass prairie research site in the United States and (2) the tallgrass prairie ecosystem should be represented in any network of long term ecological research sites.

The purposes of the proposal are: (1) to demonstrate that Kansas State University, as the steward of KPRNA and the land grant institution of the State of Kansas, already has the committment, willingness and wisdom to be involved in a program of long term ecological research; (2) to describe how the "core" measurements will be made to take best advantage of the KPRNA site characteristics and research management plan. Kansas State University and its faculty are committed to the collection of a quality data set that will make KPRNA a contributing member of a network of sites.

The compelling arguments for inclusion of KPRNA in the initial array of sites are:

(1) Tallgrass or bluestem prairie is a major ecosystem type that simply should not be overlooked or omitted. Tallgrass prairie once covered up to 6.8% of the conterminous United States (exceeded only by eastern deciduous forest, Bailey, 1978) yet undisturbed examples of this type of ecosystem are rare because it has been converted so extensively to the most productive agriculture in the world.

(2) KPRNA is the largest research natural area in bluestem prairie. It was established and is being managed by Kansas State University for research purposes that are fully compatible with long term ecological research as it is presently conceived (Anon. 1979a and b). The development of LTER at this site has been underway. The early coordination with network objectives will be mutually beneficial to both long term and short term research objectivies.

(3) KPRNA has been identified as an experimental ecological reserve (EER) in the initial network of sites (Anon. 1977b, Lauff and Reichle, 1979). KPRNA is also one of three MAB Biosphere Reserves on non-federal land in the United States.

Other advantages that argue for KPRNA's utility as a site for long term ecological research are:

(4) The proximity of KPRNA to the main campus (15 minutes) reduces logistic difficulties and facilitates ecological research by local and visiting investigators who will make additional use of the long term data base.

(5) Additional examples of native bluestem pasture are managed by the Kansas Agricultural Experiment Station through programs in range science, animal science and agronomy. For example, the Aldous plots have been burned since 1926, and experimental range units have been studied since 1950 and offer features associated with applied use of the prairie while a control area is provided by KPRNA.

(6) The Water Resources Board of the State of Kansas is supporting KPRNA as the site in Kansas for inclusion in the National Atmospheric Deposition Program.

(7) The United State Geological Survey has recently added the Kings Creek Watershed which lies within KPRNA to its National Hydrologic Benchmark Network (Biesecker and Leifeste 1975).

(8) The State Biological Survey of Kansas is taking responsibility for collection of and taxonomic work on freshwater invertebrates in the Kings Creek Watershed.

The demonstration of state wide involvement is clear.

II. Basic site description

A. Location

Konza Prairie is representative of the Flint Hills Upland, which extends from Oklahoma nearly to Nebraska, averaging about 70 km wide. It is a dissected upland with hard chert- and flint-bearing limestone layers which result in the steep-sided hills, on which are exposed the Permian limestone and shale layers. The ridges are characteristically flat, with shallow, rocky soils. The larger and wider valleys have deep permeable soils.

The vegetation is unplowed native bluestem (tallgrass or true) prairie (Andropogon-Panicum-Sorghastrum, #74 of Küchler(1964) and #2530 of the prairie division of the humid temperate domain of Bailey (1978). (Bluestem prairie also occurs as major component of prairie parklands, #2511 and #2512). Since settlement about 125 years ago KPRNA had been grazed by cattle usually from about May 1 to October 1. It was burned in the springs, probably about 3 out of 4 years. The majority of Konza Prairie was in good to excellent range condition when acquired, i.e. the native prairie species are exclusive dominants and were vigorous. Native tall grasses were not evident in 1971 on the flat lowlands, however, a hundred or more clumps of Tripsacum dactyloides, eastern gamagrass, were noticed the first summer after cattle grazing ceased. They did not come from seed but were already there, unnoticed because of the close grazing. Plants and patches of Andropogon gerardi, big bluestem, Sorghastrum nutans, indiangrass, and Panicum virgatum, switchgrass, also became more prominent. These lowland areas with deep soils now have patches of these tall grasses that grow to three meters by late summer. They already form extensive areas on some lowlands.

An inventory of vegetation was made in the first two years after acquisition to provide a basis for assessing differences in composition on different soils and treatments in the future. More than 400 species from KPRNA are documented by specimens in the KSU herbarium. Woody plants have been mapped by species

and size on the portion of KPRNA acquired in 1971. Four or more replications of each burning treatment are burned about the time that the warm-season dominant grasses start active growth (April 25 ± 10 days every year). Six different time spans between burning are included in the seven major treatments, in order to ascertain what intervals keep out woody plants, what interval results in the maximum vigor and productivity, and a frequency of burning probable in pre-settlement times. In addition, on small plots (25 x 25 m) burning is done at other seasons. Which of these treatments yields a condition that can be called "control" is part of the long term research objective. The treatment boundaries follow watershed divides so that study of hydrologic and nutrient responses to treatments are facilitated. Grazing and burning treatments are also under consideration, overlays III, IV, V show elements of this plan. It is not yet firm.

B. Management Objectives

Konza Prairie is managed to approximate the condition of the pre-settlement ecosystem in order to provide for research that will: (1) compare natural with manipulated systems, (2) account for the stability over geologic time of this important ecosystem, (3) ascertain the effects of perturbations on components of the system, and (4) evaluate productivity and interactions of various components of the system. The presence and abundance of species of plants and animals present are the same as in pre-settlement times except for bison, elk, and pronghorn antelope and their predators. We are considering the future reintroduction of the large herbivores to test their contribution to achievement of the pre-settlement condition. Simply fencing the prairie will not preserve it. Some management is required and for research purposes management should be tightly controlled rather than haphazard or left to chance.

Fire was an important influence in the pre-settlement prairie, being started by both lightning and American Indians. To approximate pre-settlement fire, and to investigate its effects, a number of burning treatments have been underway since 1972 as part of the management protocol (Fig. 2 and overlay I[1]).

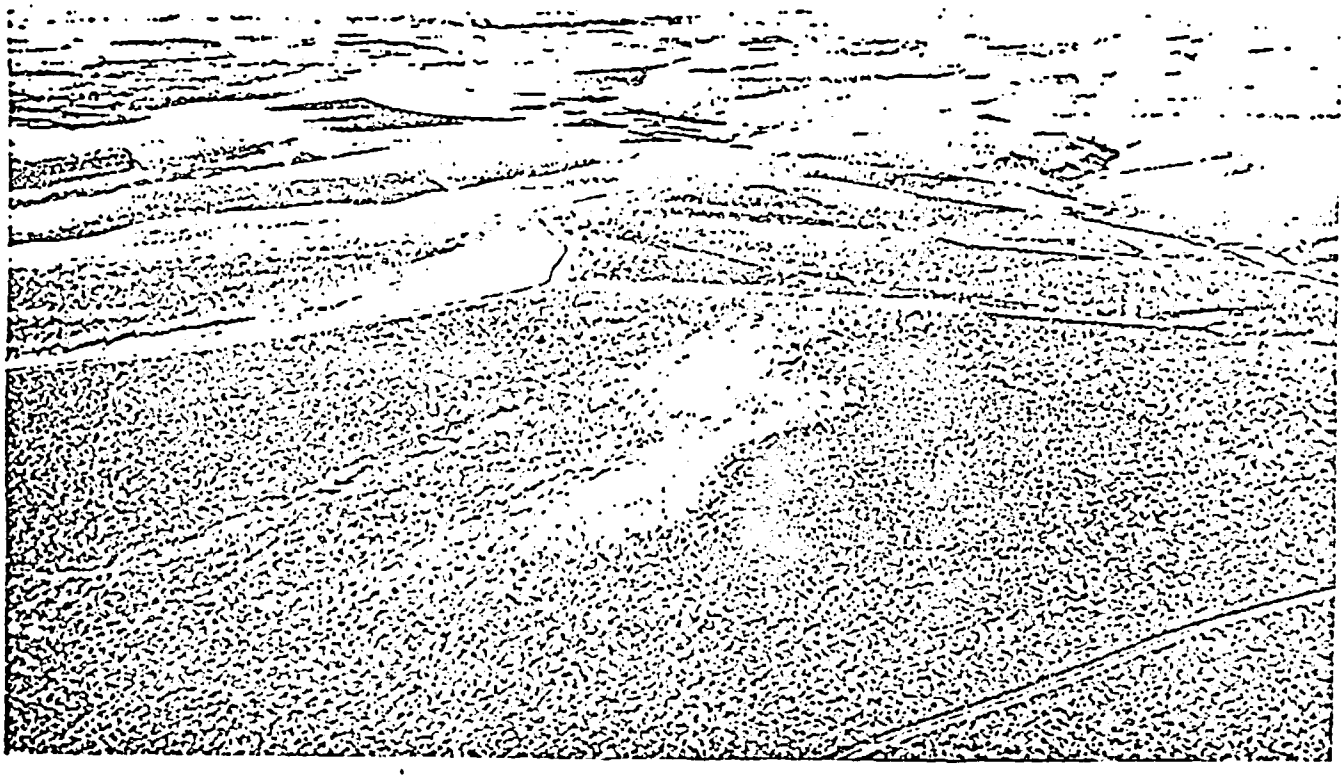

Fig. 2. An area at the south end of KPRNA showing the general aspect of the uplands. Borders between burn treatments can be seen on the ridges in the left center of the photo. The burn treatments follow watershed divides.

[1]On the inside of the back cover you will find a packet containing the USGS Swede Creek quandrangle and a set of transparent overlays that will help describe the site, its watersheds and facilities and proposed LTER research sites.

III. Research History and Data Base

The research history is short because of the recent acquisition of most of the area. Subsequent to acquisition much of the effort of the most interested potential researchers have been absorbed with mundane but, essential activity associated with securing the area and developing the management protocols. In the past year or so these people have been able to develop successful research proposals, direct thesis research and are rapidly reaching the point where solid efforts will appear in the refereed literature. All things considered the 1977-1980 "pipeline" time is relatively short. Table 1 summarizes this effort.

The use of KPRNA as a research site by KSU researchers is increasing as investigations which were underway when the site was acquired are drawn to completion and the attention of investigators can be given to the opportunities offered by a site protected for research purposes. C. W. Schenkel of the KSU Department of Geology is initiating his effort with the task of geological mapping. E. L. Skidmore and R. Ellis of the KSU Department of Agronomy and L. C. Hulbert in Biology are initiating investigation of soil physical and chemical properties. Vegetation surveys are a continuing effort and A. W. Küchler has agreed to aid with vegetation mapping in the next few growing seasons.

Several faculty of the Division of Biology are shifting research effort to KPRNA. The center of L. C. Hulbert's research effort has been with KPRNA for almost a decade and M. P. Johnson and his students have developed several investigations of prairie plant population phenomena. C. C. Smith is incorporating Konza Prairie sites into his investigations of forest regeneration and seed disperal mechanisms associated with squirrel behavior. J. L Zimmerman (Co. P.I.) has been studying territorial behavior in the dickcissel on prairie sites near Manhattan for more than ten years. His study sites now include areas on Konza Prairie and a pending request for NSF funds includes work on KPRNA. S. D. Fretwell has developed several extensions of theoretical constructs relating to nest site selection in relationship to vegetation structure. Several recent sets of observations designed to test these hypotheses have been set on Konza Prairie. G. R. Marzolf (P.I.) and his recent students have been developing investigations into prairie stream ecosystem study, including organic matter sources and decomposition. R. J. Robel and his students are using KPRNA sites for study of potentially toxic substances on bob-white quail. Local activity is high and requests for opportunity to use the site are frequent and increasing.

Table 2, which follows, lists current investigations and Table 3 is a bibliography of research papers completed, in press, or in preparation that use Konza Prairie as a research site. Table 4 is a listing of current and pending extramural financial support involving Konza Prairie RNA.

It is clear that while LTER has a rationale to stand alone, it also enhances short term experimental work because ancillary data provided by LTER will aid interpretations of site specific investigations. Furthermore, as the data set develops, the questions that will emerge because of the need for detailed interpretation and because of new insights will increase the value of both the long term and short term efforts. We expect this to be an aid to both local scientists and vistors. As study proceeds the value of LTER is enhanced. This feedback loop is one of the greatest values of site related research. The further development of KPRNA as a site for quality ecological research is a goal in sight.

A Konza Prairie library is under development. We now have an extensive reprint collection on grassland research from current and previous KSU faculty. The IBP grassland technical reports from The United States, Canada and Japan are available. Researchers are asked to deposit data sets and reprints of work done on KPRNA in this collection.

Reference collections of prairie plants, including voucher specimens from KPRNA are available in the KSU herbarium. T. M. Barkley, curator, is just completing a three year cooperative study which is yielding a Great Plains Flora. The Department of Entomology maintains a reference collection of prairie insects, and prairie invertebrates other than insects are referenced by the collections of the State Biological Survey of Kansas. Donald Huggins, of the Biological Survey is initiating taxonomic and population investigation on KPRNA's aquatic sites.

Table 1

SUMMARY OF CURRENT AND PENDING RESEARCH BY TROPHIC LEVEL

	Producers	Herbivores	2°+Consumers	Nutrient Cycling/ Decomp., Soils
FACULTY				
Number of projects	5	6	4	5
Number of investigators	6	6	4	7
Agencies	KSU, NSF, USDA	KSU, NSF, USDA, Kans. Biol. Surv., Industrial	KSU, NSF	KSU, USCG, Kans. Water Res. Inst., Kans. Geol. Surv.
GRADUATE THESES AND URP PROJECTS				
Number of projects	3	2	4	2
Number of investigators	3	3	4	2

SUMMARY OF COMPLETED RESEARCH PROJECTS BY TROPHIC LEVEL

	Producers	Herbivores	2°+Consumers	Nutrient Cycling/ Decomp., Soils
FACULTY				
Number of projects	2	4	2	1
Number of investigators	2	4	2	1
Agencies	KSU	Industrial, EPA, KSU	KSU	KSU
UNDERGRADUATE/ GRADUATE				
Number of projects	18	16	3	5
Number of investigators	18	16	3	5
Agencies	KSU, NSF-URP	KSU, NSF-URP	NSF-URP	KSU, NSF-URP

Table 2 (continued)

Graduate students

INSTREAM PHOTOSYNTHESIS AND RESPIRATION IN KINGS CREEK
A comparison of organic matter synthesis and degradation between reaches of streams in open grassland and in gallery forest. Advisor: G. R. Marzolf. NSF Doctoral Dissertation Improvement Proposal submitted Nov. 1979.

Gene L. Petersen
Div. of Biology

A COMPARATIVE SAMPLING STUDY OF BENTHIC INVERTEBRATE POPULATIONS IN A PRAIRIE STREAM
A comparison of quantitative sampling techniques for stream invertebrates and an analysis of invertebrate associations. MS Thesis 1979. Advisor: G. R. Marzolf.

Gene L. Petersen
Div. Biology

THE ODONATA OF THE KONZA PRAIRIE RESEARCH NATURAL AREA
An inventory of these aquatic insects in ponds. This study is not a research study for an advanced degree. Advisor: G. Richard Marzolf.

Joseph Arruda,
Div. of Biology, KSU

EFFECTS OF AN ARTIFICIAL FOOD SUPPLY ON POPULATIONS OF PEROMYSCUS
Population density, age structure, sex ratio, and survival rates are to be compared in populations with and without an added food supply. M.S. research study. Major professor: Stephen D. Fretwell.

Ned L. Bork
Div. of Biology, KSU

WHY DO LARGER MALE DICKCISSELS (SPIZA AMERICANA) HAVE SMALLER TERRITORIES AND FEWER FEMALES THAN MEDIUM SIZED MALES?
Three hypotheses are being tested by gathering data on time budgets for both males and females, population density, sex ratio, vegetative volume, territory size, clutch size, hatching success, percent fledging and cowbird parasitism in populations on Konza Prairie and an old field on Fort Riley Military Reservation. Ph.D. research. Major professor: John L. Zimmerman.

Elmer J. Finck,
Div. of Biology, KSU

ADDITIONS TO THE FLORA OF KONZA PRAIRIE RESEARCH NATURAL AREA
This is a continuation of a study during a 10-week undergraduate research program in an earlier summer. It is not a research project for an advanced degree. Advisor: Theodore M. Barkley.

Craig C. Freeman,
Div. of Biology, KSU

Table 2 (continued)

ARCHEOLOGICAL SURVEY OF KONZA PRAIRIE RESEARCH NATURAL AREA

Evidences of sites of occupation or use by American Indians are being sought. An objective is to ascertain the habitats utilized in this type of prairie. The project is not for an advanced degree. Advisor: Patricia J. O'Brien.

Robert Hamilton,
Former student of anthropology,
KSU

EFFECTS OF LITTER ACCUMULATION AND BURNING ON EARTHWORM POPULATIONS IN PRAIRIE SOIL

The earthworm populations in burned and unburned prairie is being studied. Plans also include altering population density to ascertain effects on the vegetation. Ph.D. research. Major professor: Deborah Rabinowich.

Samuel W. James
Div. of Biological Sciences,
Univ. of Michigan

EFFECT OF SHREDDING AQUATIC INSECTS ON DECOMPOSITION RATES OF TREE LEAVES IN A PRAIRIE STREAM

Study of the relative decomposition rates of leaves of different species of trees in riffles and in pools with and without shredding insects. The roles of shredding insects, bacteria, and fungi are to be elucidated. Finally, the coarse particulate organic matter transported by the stream is to be measured. Ph.D. research. Major professor: G. Richard Marzolf.

David L. Smith,
Div. of Biology, KSU

THE IMPORTANCE OF SELF-FERTILIZATION IN INSECT-ATTRACTING PRAIRIE PLANTS

The hypothesis being tested is that floral mechanisms aiding self-fertilization are the rule for species in tallgrass prairie that attract insects. Also, it is intended to ascertain if the percentage of species with autogamous flowering strategies changes as would be predicted from climatic effects on pollinators. Ph.D. research. Major professor: Michael P. Johnson.

Dana K. Townsend,
Div. of Biology, KSU

NESTING AND FLEDGLING SUCCESS OF MOURNING DOVES (ZENAIDURA MACROURA CAROLINENSIS) IN WOODED AND BURNED AND UNBURNED PRAIRIE AREAS

Nests in prairie are located weekly by dragging a rope and in woods by observations while walking. Nests are marked and rechecked for evaluation of fledgling success. The study allows ascertaining both density of nests and reproductive success in various habitats. This study is not for an advanced degree. Advisor: John L. Zimmerman.

Jerry K. Wilson
(Research Assistant)
Elmer J. Finck
(Graduate Student)
Div. of Biology, KSU

Table 2 (continued)

Undergraduate students

CENSUS OF RAPTORS ON KONZA PRAIRIE (Robert Broyles; Stephen D. Fretwell)

RELATION BETWEEN FLOWER DENSITY, NUMBER OF SPECIES FLOWERING, AND THE DURATION OF FLOWERING. Tests the hypothesis that during periods of high floral density, increased competition for insect pollinators will be expressed by increasing flowering duration or increasing the variance in flowering times within species (Susan Kenney; Michael P. Johnson).—7

RESEARCH PROJECTS COMPLETED OR INACTIVE

Faculty or other scientists

A SURVEY OF AQUATIC AND SEMIAQUATIC INSECTS

COLONIZATION OF A PRAIRIE POND BY AQUATIC AND SEMI-AQUATIC INSECTS

DIVERSITY INDICES AND TROPHIC LEVEL DISTRIBUTIONS OF TERRESTRIAL INSECTS
A reference collection of insects of Konza Prairie was made, and population estimates on some species.

Dianne M. Calabrese,
Div. of Biology, KSU

IS RUNNEL USEFUL AS A GROWTH STIMULANT IN CATTLE?
Short-term study on smooth brome fields. Funded by Dow Chemical Company.

EFFECT OF THE FEED ADDITIVE AVOPARCIN ON GROWTH OF CATTLE
Short-term study on smooth brome fields. Funded by American Cyanimid Company.

Larry Corah,
Dept. of Animal Sciences, KSU

AZOTOBACTER POPULATIONS IN DIFFERENT SOILS

John O. Harris,
Div. of Biology, KSU

ALLOCATION OF ENERGY IN VERNONIA BALDWINI
Allocation of energy for vegetative and reproductive uses was assessed in this perennial increaser in the bluestem prairie. Funded by Kansas Agricultural Experiment Station and the KSU Bureau of General Research.

Michael P. Johnson,
Div. of Biology, KSU

GRASSHOPPER SPECIES POPULATION CHANGES ON BURNED AND UNBURNED BLUESTEM PRAIRIE ON TWO SOILS

Herbert C. Knutson,
Dept. of Entomology, KSU

EVOLUTION OF POLLINATING MECHANISMS IN PRAIRIE PLANTS
The relationship of the physical environment to the pollinating mechanism was studied for two summers by relating type of pollinating insect (generalist vs. specialist) or wind on the spacing of the plant species. Funded by Kansas Agricultural Experiment Station.

Christopher C. Smith,
Div. of Biology, KSU

Undergraduate students

The majority of the following were participants in National Science Foundation funded Undergraduate Research Participation Programs (URP). The Division of Biology at KSU has received funding for these programs five summers and three academic years. The supervising faculty member is given in parentheses.

PHENOLOGICAL SURVEY OF FLOWERING VASCULAR PLANTS (James R. Aldrich, URP, 1978; Michael P. Johnson)

HABITAT DISTRIBUTION, AGGRESSION, AND BODY SIZE IN DICKCISSELS AND REDWING BLACKBIRDS (Linda Allen and David Gibson, URP, 1975; Stephen D. Fretwell)

NICHE SEPARATION IN SEED EATING RODENTS (George Athey, URP, 1974; Christopher C. Smith)

CHANGES IN BIOLOGICAL NITROGEN FIXATION AND SOIL NITROGEN CONTENTS IN BURNED AND UNBURNED PRAIRIE (Sharon Bennett, URP, 1978; Peter Wong)

SURVEY OF MAMMALIAN PREDATORS (James Berry, URP, 1977; Bennett A. Brown)

REPRODUCTIVE SUCCESS OF PSORALEA FLORIBUNDA IN RELATION TO WEATHER CONDITIONS, PLANT DENSITY, AND INSECT POLLINATORS (Lynn Bills, URP, 1975; Christopher C. Smith)

RATE OF DECOMPOSITION OF TRAMPLED AND UNTRAMPLED STANDING DEAD VEGETATION (Russell Brehm, 1978; Lloyd C. Hulbert)

TIME BUDGETS OF DICKCISSELS IN VARIOUS HABITATS (Stephen Bump, URP, 1978; John L. Zimmerman)

FLOWERING PHENOLOGY OF SOME KONZA WILDFLOWERS (Sue Campbell, URP, 1975; Michael P. Johnson)

LICHEN DISTRIBUTION AT SELECTED SITES (Caroline Cox, URP, 1974; James A. Goss)

THE POLLINATION ECOLOGY OF ASCLEPIAS SULLIVANTII (Mary Davis, URP, 1975; R. Stimson Wilcox)

EFFECT OF STANDING DEAD PLANTS ON STEM DENSITY IN BLUESTEM PRAIRIE (Dee Ann Dokken, URP, 1974; Lloyd C. Hulbert)

EFFECTS OF GRAZING AND BURNING ON PRAIRIE BIRD SPECIES (William Eddleman, URP, 1974; John L. Zimmerman)

NESTING HABITS OF THE DICKCISSEL AND RED-WINGED BLACKBIRD (Charles F. Facemire, URP, 1978; John L. Zimmerman)

COMPOSITION AND COVERAGE OF SPRING-BURNED AND UNBURNED VEGETATION ON FOUR SOILS (James Ferris, URP, 1975; Lloyd C. Hulbert)

MOURNING DOVE NESTING DENSITY AND PRODUCTION IN FOREST AND PRAIRIE (Mark Fox, URP, 1977; John L. Zimmerman)

FLORISTIC SURVEY OF KONZA PRAIRIE (Craig C. Freeman, URP, 1977; Theodore M. Barkley)

PLANT SPECIES FEEDING CONSTANCY AND FORAGING PATTERNS OF THE BUMBLEBEE (Sarah Gerould, URP, 1975; H. Derrick Blocker)

GROWTH RATES OF THE BROWN-HEADED COWBIRD IN NESTS OF DIFFERENT HOST SPECIES (Scott Hatch, URP, 1974; John L. Zimmerman)

POLLINATION BIOLOGY OF CALYSTEGIA SEPIUM, AND RADIOACTIVE TRACKING OF POLLEN IN RUELLIA HUMILIS (Jill Howard, URP, 1979; A. Spencer Tomb)

INHIBITION OF NITRIFICATION AND BACTERIA BY PLANT TOXINS (Gene Keltner, URP, 1974; John O. Harris)

A COMPARISON OF BIRD DENSITIES AND THE EFFECTS AND UTILIZATION OF SONG PERCHES IN BURNED AND UNBURNED PRAIRIE (Jan Knodel, URP, 1979; John L. Zimmerman)

REPRODUCTIVE BIOLOGY OF RUELLIA HUMILIS (ACANTHACEAE) (Dana Komarek, URP, 1977; A. Spencer Tomb)

EFFECTS OF FIRE IN TALLGRASS PRAIRIE RELATED TO SMALL MAMMAL POPULATIONS AND SPECIES DIVERSITY (Eric Larsen, URP, 1974; Robert J. Robel)

COMPARISON OF SMALL MAMMAL POPULATIONS BETWEEN NATURAL AREAS AND AREAS IN FLUENCED BY RANCHING METHODS (Elaine Mader, URP, 1977; Bennett A. Brown)

TAXONOMIC STUDY OF PLANTS OF KONZA PRAIRIE (Linda Marple, URP, 1975; Theodore M. Barkley)

A BEHAVIORAL EVALUATION OF THE HAZARDS OF AN EXPERIMENTAL CARBAMATE PESTICIDE ON BOBWHITE (Michael Morrow, URP, 1979; Robert J. Robel)

EFFECT OF RAIN ON SOIL COMPACTION AFTER BURNING (Robert Patton)

CHROMOSOME ATLAS FOR SELECTED PLANTS OF KONZA PRAIRIE (Frank Rohwer, URP, 1975: A. Spencer Tomb)

COMPARISON OF VEGETATION COMPOSITION ANALYSIS METHODS (Daniel Ronnebaum; Clenton E. Owensby)

ECOLOGICAL COMPARISON OF WOODY VEGETATION ON HERBICIDE-TREATED AND UNTREATED AREAS (Phyllis Sandford, URP, 1977; Lloyd C. Hulbert)

EFFECTS OF GRAZING AND BURNING ON RODENT POPULATIONS (Craig Schartz, URP, 1977; Bennett A. Brown)

EFFECTS OF FIRE FREQUENCY ON NESTING SUCCESS OF PRAIRIE BIRDS (Melody Serena, URP, 1974; Stephen D. Fretwell)

OPTIMIZATION OF CLUTCH SIZE BY RED-WINGED BLACKBIRDS (Frank Shipley, URP, 1974; Stephen D. Fretwell)

PLANT STRATEGIES FOR INSECT POLLINATION (Emilie Smith, URP, 1975; Michael P. Johnson)

FOOD VALUE OF SOME EDIBLE PLANTS OF KONZA PRAIRIE (Carol Stocker, URP, 1975; James A. Goss)

VEGETATIVE KEY TO THE GRASSES OF KONZA PRAIRIE. (Jean Stramel, URP, 1979; Theodore M. Barkley)

REPRODUCTIVE STRATEGY OF THE RED-WINGED BLACKBIRD (David Temme, URP, 1977; Stephen D. Fretwell)

HABITAT SELECTION BY FEMALE SPIZA AMERICANA (Harvard Townsend, URP, 1979; Stephen D. Fretwell)

ECOLOGY OF ENERGY ALLOCATION IN PRAIRIE PLANT SPECIES (David Trombold, URP, 1974; Michael P. Johnson)

THE DENSITY-DEPENDENT EFFECT OF FOOD AND PREDATION ON THE PRODUCTIVITY OF THE DICKCISSEL (SPIZA AMERICANA) (Steven Wegert, 1977; Stephen D. Fretwell)

AN ASSESSMENT OF NITROGEN FIXATION ON KONZA PRAIRIE (Elizabeth Woltersom, URP, 1977; Peter P. Wong)

Table 3

PUBLICATIONS OF KONZA STUDIES

Dokken, D. A., and L. C. Hulbert. 1978. Effects of standing dead on stem density in bluestem prairie. Fifth Midwest Prairie Conference Proc., Iowa State Univ., August 1976. pp. 78-81.

Freeman, C. 1977. An annotated list of the vascular flora of the Konza Prairie Research Natural Area. KSU Herbarium Report.

Fretwell, S. D. 1973. The regulation of bird populations on Konza Prairie. The effects of events off the prairie. Third Midwest Prairie Conf. Proc. 71-76.

Harris, J. O. 1973. Azotobacter of the Konza Prairie. Third Midwest Prairie Conf. Proc. 53-54.

Hulbert, L. C. 1978. Controlling experimental bluestem prairie fires. Fifth Midwest Prairie Conference Proc. pp. 169-171.

Hulbert, L. C. 1973. Management of Konza Prairie to approximate pre-whiteman fire influences. Third Midwest Prairie Conf. Proc. pp. 14-17.

Johnson, M. P., Oksanen, and C. Finney. 1978. The use of beta attenuation to measure productivity, foliage height diversity, and vegetational heterogeneity in tall grass prairie. Fifth Midwest Prairie Conf. Proc. pp. 74-77.

Knodel, J. 1980. Breeding bird census. Burned and unburned prairie. American Birds. (In Press)

Marple, L. 1975. An annotated checklist of plants on the Konza Prairie Research Natural Area. KSU Herbarium Report.

Shipley, F. S. 1979. Predation on red-winged blackbird eggs and nestlings. Wilson Bull. 91:426-433.

Smith, C. C. 1973. The distribution of energy into sexual and asexual reproduction in wild strawberries (Fragaria virginiana). Third Midwest Prairie Conf. Proc. pp. 55-60.

Udevitz, M. S., C. A. Howard, R. J. Robel, and B. Curnutte, Jr. 1980. Lead contamination in insects and birds near an Interstate Highway, Kansas. Environ. Ent. (In Press)

Petersen, G. L. 1980. Invertebrate associations in Kings Creek. In. Prep.

Killingbeck, K. T. 1980. Translocation of nutrients as a factor in competion and tree species dominance. In prep.

Smith, D. L. and G. R. Marzolf. 1980. Instream decomposition of leaf litter from trees with different nutrient translocation properties. In prep.

Smith, D. L. and G. R. Marzolf. 1981. Role of insects in leaf decomposition in streams. In prep.

Marzolf, G. R. and K. T. Killingbeck. 1981. Coupling of aquatic and terrestrial processes in nutrient conservation. In prep.

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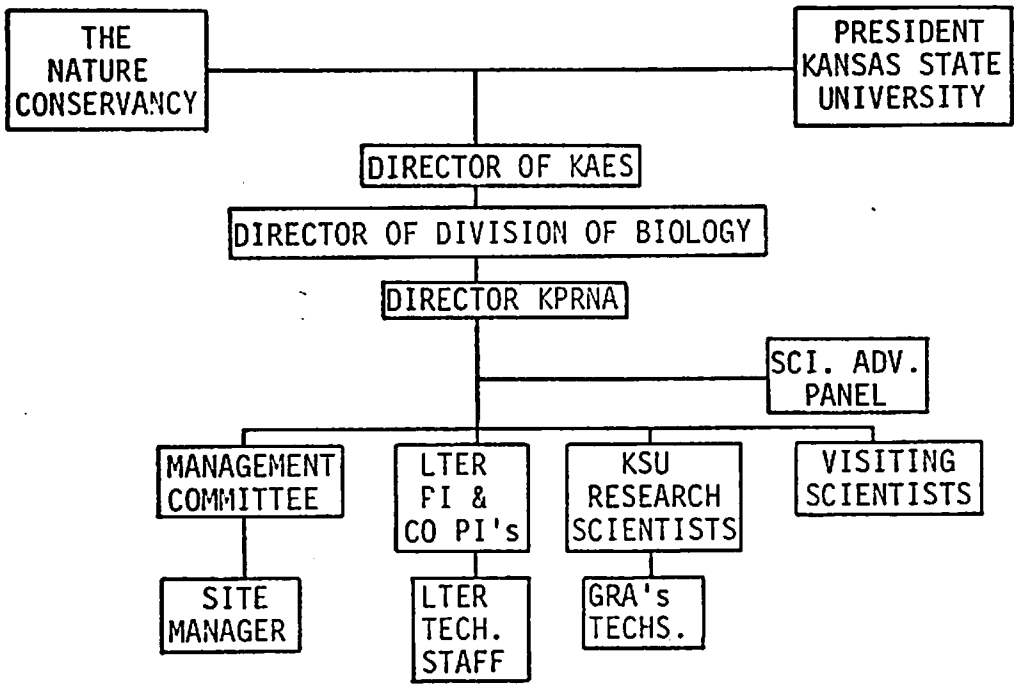
IV. Site Administration and Advisory Groups

A. The following organizational chart describes the chain of responsibility for the area. The Articles of Governance (1977) are in Appendix B.



B. Kansas State University's Agricultural Experiment Station; the responsible agency

In March of 1887 the Hatch Act was signed into law by President Grover Cleveland, enabling the establishment of agricultural experiment stations with federal support throughout the nation. Two days after the act became law, the Kansas legislature accepted the provisions of the act (March 4, 1887) and created the Kansas Agricultural Experiment Station as a component of the then Kansas State Agricultural College, in Manhattan. Since this beginning, the Kansas Agricultural Experiment Station (KAES) has existed to encourage, support and generally coordinate research that ultimately relates to agriculture and the quality of life in the Great Plains and in similar agro-ecosystems throughout the world. The KAES now encompasses several branch stations and experimental facilities throughout the state. The KAES also serves as a coordinating body for scientific research at the University. It acts as an enabling agency for administration of grants and contracts, for securing and holding research sites, and as an administrative mechanism by which the research policies and programs of the University may be carried out. The Director of the AES at KSU functions in a manner that includes the duties often assigned to "Dean of Research" at other universities. Kansas State University has an established commitment and is recognized for long term research effort.

The College of Agriculture at KSU maintains three research programs that relate to this proposal, and all three of these efforts are sponsored by the KAES. The projects are directly managed by faculty of the Departments of Agronomy and and Animal Sciences. The projects are as follows:

1. The Aldous Burn Plots, named for the late Professor A. E. Aldous who initiated a series of studies on the effects of burning on the prairie. The plots consist of 10 tracts, each 2 rods by 4 rods, in which five treatments have been performed regularly since 1926.

Data and conclusions from the Aldous Burn Plots have been accumulated and published in a long series of papers, originally by Aldous himself, then by Anderson and currently by C. E. Owensby. The project represents the longest continuing burning research on natural vegetation in the country.

2. The Kansas State University Experimental Range Research Unit (Donaldson Pastures) consists of 1152 acres of tallgrass prairie. It was acquired by the University in 1946, and by 1950, three long-term studies had been initiated. All three were ultimately focused on livestock production, with a major question being the role of fire, grazing intensity and deferred rotation schemes on range condition and beef production.

The effects of nitrogen fertilization on prairie pasture lands has been investigated since 1972, and it entailed nitrogen enrichment at the rate of 40 lbs. per acre, on both burned and unburned pastures. The same basic data have been collected, e.g., botanical census, herbage yields and livestock gain. Sophisticated analyses were made on carbohydrate and nitrogen content in Andropogon gerardi.

3. Polled Hereford Research Unit is an experimental range site of 1280 acres. The site is given over to the study of grazing rotations with a late-season rest, in a "cow-calf operation." It is divided into subunits, and the same basic data are collected as in the range research units, i.e., botanical census, herbage yield, forage quality, plus the unique features of animal data such as calving intervals.

Data were acculumated for all three studies through a periodic botanical census, herbage yield measurements (which included separate analyses for mulch, forbs, grasses and woody-plant species-components), and livestock gains. Secondary projects have included soil-moisture analyses for six years.

A wealth of data and many publications have been produced at these three sites. Agronomic data are kept by the Agronomy Department and studies on animal nutrition, physiology and related matters of livestock production are made by the Department of Animal Science and Industry.

We feel that the addition of KPRNA to the University's research facilities adds a level of experimental control to these agricultural manipulations that increases their value to science and utility to agriculture.

C. Kansas State University Division of Biology - A Short History of KPRNA

A group was formed in 1955 to stimulate acquisition of bluestem prairie research natural area by KSU. In March, 1958, a report was filed with the Administration of the University, and during the next decade, studies intensified to locate the best possible site and to identify methods of acquisition. The intensity of the search quickened in the mid sixties at a time when a Division of Biology with strong research orientation was replacing departments of bacteriology, botany and zoology. These changes were greatly aided by a special development award from the National Science Foundation in 1967.

Criteria for an acceptable site were: (1) Native biota must be in good condition, (2) soils of agricultural quality as well as steep and/or rocky sites with native prairie should be present, and (3) the site should be close

to the KSU campus to facilitate research and to minimize costs. Eventually, field-experience enabled several sites to be considered, and a favorable reception for the project came from The Nature Conservancy.

A 371 ha tract answering the criteria for an acceptable research natural area, was purchased by The Nature Conservancy in 1971. This site forms the southern section of today's KPRNA. Title for this tract was transferred by The Nature Conservancy to the KSU Foundation. The site was greatly expanded in 1977 with the acquisition of the 2921 ha Dewey Ranch, and in December 1977 by the acquisition of the 194 ha Thowe Tract. The Nature Conservancy was the agent responsible for these acquisitions and has retained title to the Dewey Ranch section of KPRNA. Kansas State University acts as owner-operator of the site through special lease agreements. It should be noted that The Nature Conservancy expects KPRNA to be used for long term research in perpetuity.

KPRNA now totals 3486 ha making it one of the largest research natural areas in the country and the premier tallgrass prairie research site.

E. Site promotion

Recent site promotion has included invitations for research in the Bulletin of Ecological Society of America (in press), poster sessions at ESA meetings (most recently 1978, Athens, GA) and the personal communications of the scientific advisory panel. We also routinely include a visit to KPRNA for ecologists who visit KSU for the Division of Biology Seminar Series. In 1979-80 the following have visited KPRNA. Francis Evans, Univ. of Michigan; George Woodwell, MBL; Gene Likens, Cornell Univ.: Wm. Reiners, Dartmouth Coll.; Kenneth Cummins, Oregon State Univ.; Daniel Simberloff, Flordia State Univ.; Robert Woodmansee, Colorado State Univ.; Jerry Elwood, Oak Ridge Nat'l Laboratory; James Barnes, Bringham Young Univ.; Eric Pianka, Univ. Texas; Frank Gould, Texas A & M Univ.; Donald J. Hall, Michigan State Univ.; Donald Kauffman, NSF; George Williams, Washington State Univ.; George W. Saunders, Dept. of Energy; David C. Coleman, Colorado State Univ.; Larry L. Tieszen, Augustana College; and Frank C. Bellrose, Illinois Nat. Hist. Survey.

External review of KPRNA operation has been provided for since 1977 when the Scientific Advisory Panel met here for the first time. Members in attendance for that meeting were:

Eric G. Bolen, Texas Tech. University
David C. Coleman, Colorado State University
James L. Hamrick, University of Kansas
David W. Kitchen, Humboldt State University
Allan L. Lovaas, National Park Service, Omaha, NB
Milo J. Shult, Texas Agricultural Extension Service
Richard G. Wiegert, University of Georgia

The present non-KSU members of the Scientific Advisory Panel are:

David C. Coleman, Colorado State University
Patricia Werner, Michigan State University
Paul G. Risser, Oklahoma University
Richard G. Wiegert, University of Georgia
Allan L. Lovaas, National Park Service, Omaha, NB
James L. Hamrick, Kansas University
Paul Bultsma, Ordway Prairie, SD
Rex Boner, The Nature Conservancy

We intend that members of this group will visit the site for review purposes at approximately three year intervals.

For promotion among non-scientist public we have prepared the brochure included in the map pocket.

V. Statements of commitment and support

In the following paragraphs the questions of commitment and support as enumerated in NSF program announcement (79-64) are addressed.

A. Continuity of leadership

This proposal presents an LTER program for a relatively new site. The administration of Kansas State University and the Kansas Agricultural Experiment Station have considered the benefits to the national interest and to the science of ecology that can come about by making the KPRNA available to become a part of this program. The quid pro quo is the federal financial support that will hasten the development of the site as a center of high quality research in grassland ecology. The Director of the Konza Prairie Research Natural Area (currently Lloyd C. Hulbert) is appointed by the University through the Agricultural Experiment Station and the Division of Biology. The duties of the Director include the responsibility for administration maintenence, protection and coordination of research use of the area. This position is permanent and fully funded by Kansas Agricultural Experiment Station resources and represents the primary commitment to continual leadership. Further commitments to the KPRNA and, therefore, to LTER goals, are discussed below.

B. Institutional cost sharing.

Institutional cost sharing takes several forms. The Kansas Agricultural Experiment Station funds the basic operation of the site through a legislative line item appropriation supplemented by allotment of other funds. Besides other costs of operation, these funds pay the salary of two full-time research assistants. One is primarily responsible for operation of the area, including maintenance of the long-term burning treatments. The other is primarily responsible for gathering such data as vegetation composition and productivity and subsequent computer analysis, tasks which would become part of the LTER program. The University also contributes the salary of faculty whose research focuses on the site. In this proposal there are seven faculty co-investigators; three of these are on nine month salary and three are on twelve month salary paid by KSU. (Of the latter, one is the Director of KPRNA and one is the curator of the herbarium. The seventh currently is being recruited.) In addition to salaries, the University supports the research of these individuals through KAES funds from state and Hatch Act monies. The support is solid, substantial and usually enthusiastic. An example of the use of discretionary funds to support the intentions of LTER goals is the fact that the Agricultural Experiment Station will bear the cost of establishing a National Atmospheric Deposition Program collection site on Konza Prairie and will pay the annual costs of this program until those costs are included in the state budget of the Kansas Water Resources Board.

Other State agencies are contributing to the research program on KPRNA. The State Biological Survey is committed to conduct an initial taxonomic survey of aquatic invertebrates to be later developed into a long term study

of population fluctuations and recolonization mechanisms in intermittent streams. This work is headed by Donald Huggins, currator of invertebrate collections. The Kansas Geological Survey is initiating investigations of ground water chemistry and ground water movement. This was started in 1978 by D. L. Whittemore, senior scientist.

The United States Geological Survey has established the Kings Creek watershed as a benchmark in its national hydrologic network of benchmark watersheds. The costs of continuous stream gauging and monthly chemical analysis are fully supported by this program. The U.S. Geological Survey and the Kansas Geological Survey are cooperating and will install proportional stream sampling equipment at the same site. This equipment will be in place by spring 1980, and the water analysis will be performed by the Kansas Geological Survey.

C. Physical facilities.

The proximity of Konza Prairie to the City of Manhattan and to the KSU campus reduces the significance of on-site facilities a propo both living quarters and laboratory requirements. Even so, the on-site facilities as described below are presently good and potentially excellent. Funds for development of these facilities are being sought privately and are not requested or necessary for the initiation of LTER.

D. Site integrity

The Nature Conservancy, a private, nonprofit, membership-governed organization, has supplied the area to KSU for ecological research. The Nature Conservancy has an exemplary record in ensuring site integrity. KPRNA is an ecological preserve for the "indefinite future" meant to be "in perpetuity."

Another element of integrity is that of protection from disturbance such as vandalism. This is, of course, less certainly discussed here. The site has not yet been troubled by vandals, but vandalism will always be a concern and is, in part, the reason that staff live on the site permanently. The site is surrounded by farmers and ranchers who have been on their land, in many cases, all their lives. They have visited KPRNA, know our objectives and we have successfully gained their support.

E. Conflict in use of the site.

There is none.

F. Long term agreements with site owners.

They are firm, see item D above.

VI. LTER Core Research on KPRNA

The Konza Prairie was sought, identified, purchased and, in the period from 1971 to 1977, set aside for the purpose of long term ecological research.

The management objectives described on page four et seq. were developed to meet long term research objectives. Part of the anticipated research use of KPRNA is short term and requires intensive effort; it will take advantage of

the long term management scheme and will be useful in the interpretation of the long term record. The patterns of changes in response to burning and grazing treatments may be ascertained with the time series of measurements outlined below. Methodology and more narrative follows the outline.

These methods are drafted in part from guidelines accompanying core measurements (Anon. 1979b) and in part from our understanding of what is useful and necessary for KPRNA, that is, site specific. We are more concerned than anyone that in the future these efforts will have yielded a quality set of data. Additionally we feel that it is essential that PI's of initial sites in the network begin to coordinate methods and objectives of the LTER network. The travel budget reflects this need.

The following choices of measures and methods are not specifically intended to serve any known "systems model" though systems components from known models are clearly represented by the choices. Neither have we made choices purposely to serve specific population theory though the populations chosen represent an array of life history patterns or survival strategies that will be valuable. In all measures we seek to represent the prairie, provide qualitative and quantitative data with error estimates and ensure that, once started, collection of these data will continue to make sense. During the first five to ten years we expect to develop and refine the measurements for profitable use over time, both as we seek to answer site specific questions and as we contribute to network objectives when they emerge.

MEASURES

LTER Core Research and KPRNA Contribution

1) pattern and control of primary production

(a) species composition of prairie vegetation (LCH)
(b) canopy coverage (LCH)
(c) above ground biomass and photosynthetic area (LCH)
(d) flowering stem density, height and weight; and seed number and weight for three grasses (Andropogon gerardi big bluestem, Sorghastrum nutans indiangrass, Andropogon scoparius little bluestem). (LCH).
(These four measures to be made annually at twelve sites; 2 soils x 2 burn treatments x 3 grazing treatments; c.f. map overlay VII)

(e) map woody vegetation every ten years, vertical aerial photography and LANDSAT imagery (LCH)
(f) gallery forest litterfall at three sites (GRM)
(g) instream photosynthesis (GRM)

2) dynamics of populations of organisms selected to represent trophic structure

(h) three grasshopper species; early, mid and late growing season herbivores of dominant grasses
(i) three rodents; Microtus, Sigmodon and Neotoma (JLZ)
[(h) and (i) at same sites as (a), (b) (c) and (d) above]
(j) bird species diversity on 2 burn treatments x 2 grazing treatments + gallery forest (JLZ)
(k) greater prairie chicken males on spring booming grounds and sex and age data from January trapping on feeding areas (RJR)
(l) phenological records (apply to core question 1 and 2) (MPJ)

3) pattern and control of organic matter accumulation and in surface layers and sediments

(m) deep soil cores at 10 year intervals; shallow composite cores at year intervals. (LCH)
(n) prairie litter decomposition (LCH)
(o) gallery forest litter decomposition (GRM)
(p) Annual estimate of organic matter stored in stream bed (GRM)

4) patterns of inorganic inputs and movements of nutrients through soils, ground water and surface waters

(q) National Atmospheric Deposition Program will provide wet and dryfall input data (GRM)
(r) U.S.G.S. provides continuous data from the Benchmark Hydrologic site on Kings Creek (GRM)
(s) The Kansas Geological Survey investigation of ground water chemistry (GRM)
(t) K.G.S. installation of proportional stream sampler to evaluate the exports of materials by intermittent runoff events. (GRM)
(u) ground water level will be measured in cased wells (GRM)

5) patterns and frequency of disturbance

(v) core physical measurements (meteorological, LDB and atmospheric Chem, CEM)

6) Data storage and retrieval (MPJ)

METHODS

1) Pattern and control of primary production.

(a) Species composition: Long-term records of composition should be one of the, if not the, best index of stability, resilience, and indicators of change in the system. Numbers of the more common species are to be measured annually by the modified step-point method (Owensby 1973). Changes in number of stems (tillers), changes in the frequency of common species from year to year and comparisons between different soils and treatments are provided by this method.

(b) Canopy coverage and frequency will be recorded for twelve sites in 10 m^2 plots, 20 plots per site (overlay VII). Two sites will be rated every year; the rest every fifth year. The method is adapted from Daubenmire (1959). The large plot size is needed to rate the scarce species, some of which are more useful indicators than the more common species. Most species, especially the forbs, are readily rated by this method, but some grasses are difficult to distinguish. The step-point method complements the canopy-coverage method.

Data for five different years, 200 to 400 plots per year, have already been obtained by the canopy coverage method. We would like to rate all LTER sites each year, and rate more frequently only if experience proves that it is feasible.

Both C_3 and C_4 species of grasses and forbs will be assessed by this method. C_4 species are clearly dominant, but C_3 species occur and may be important for certain grazers.

(c) Above-ground biomass and photosynthetic area.
Above-ground biomass, separated into live and dead, is to be measured monthly from May through September. To evaluate changes over winter, standing biomass is to be measured in the late autumn (November) and spring (late March or early April).

Because clipping is both labor intensive and disturbing of the site, biomass will be measured by the beta-attenuation technique using apparatus developed at KSU (Johnson et al. 1978). Beta particles passing though the vegetation from a source are counted at five heights. The counts per time are converted to biomass by calibrating against clipped plots. The clipping may be done off the LTER sites so they are not disturbed.

Samples of the clipped vegetation used to calibrate the beta-attenuation method are to be measured for photosynthetic area. Initially a combination of methods will be tried, including computations from measurements and use of leaf area measuring machines, to ascertain the most appropriate procedure. The photosynthetic area and live biomass will be correlated throughout the growing season to ascertain the relationship and its variance. After these comparisons are made we will decide on a long-term procedure.

We expect to archive these clipped samples for further study. They will be pressed, dried and stored in plastic.

(d) Flowering stem density, height, and weight, and seed number and weight for three dominant grass species; big bluestem, indiangrass, and little bluestem. These measures are included for the following reasons:

1. The beta-attenuation method does not accurately measure tall flowering stems. Addition of these manual measures will compensate for this inaccuracy.
2. Energy allotment to reproductive activity by major species is an important attribute.
3. These species differ in response to weather and treatment, and will provide a range of measures of these responses.
4. These measures are relatively quick, yet useful.

Height is to be measured by the point-centered quarter method and density by counts in plots. The size of plots will vary from year to year depending on flowering stem density. The measurements are to be made at maturity of the flowering stems.

For each of the three species, 100 flowering stems will be collected at maturity so that we may ascertain weight of flowering stems per unit area, number of seeds per unit area, weight of seeds, and seed viability.

(e) Relationship of Bluestem Prairie to Deciduous Forest

Konza Prairie is especially suited to studies on the relationship of bluestem prairie and deciduous forest. Long-term records were started in 1972. Species identification and height of every tree was mapped in 1972 through 1974 on the old (Geary County)

portion of Konza Prairie. Camera point photographs have been made every year, and oblique aerial photographs have been made regularly.

As part of the LTER program we will:

1. Map the woody plants every 10 years on the Geary County portion of Konza Prairie and on selected parts of the expanded area.
2. Revise the selection of camera points and develop a schedule of times for photography.
3. The frequent, regular Landsat imagery will be correlated with seasonal and annual vegetation changes. Standard aerial photography by the USDA has been used and will continue. Aerial photographs will be taken from low elevations. This can be done by use of the apparatus for holding a motor-driven camera on the outside of a small plane, as described by Meyer and Grumstrup (1978) and Heintz, Lewis, and Waller (1979). Standard color and infra-red color photographs will be made at various seasons.

(f) Surrounded by the bluestem prairie in the Konza Prairie Research Natural Area (KPRNA) are deciduous gallery forests which occupy the margins of the lower portions of intermittent prairie water courses. These hackberry-oak-ash woodlands (Celtis occidentalis, Quercus macrocarpa, Q. prinoides, and Fraxinus pennsylvanica) are a major force in the energy and nutrient budgets of several KPRNA watersheds, even though the land area they cover is small in comparison to the adjacent tallgrass prairie. Since these woodland communities exist at the land-water interface, their spectrum of influence includes both terrestrial and aquatic ecosystems.

The deciduous woodland communities in the KPRNA are appropriate for long-term ecological research effort because they are gallery forests; these are forests existing along a watercourse in an area otherwise devoid of extensive forest growth. These stands are "obligate riparian" rather than "facultative riparian" in the KPRNA.

In the forest along King's Creek, nutrient concentrations in vegetation and soils have been studied in 40m x 40m permanent plots since 1978. The collection of litterfall was begun in the fall of 1978 and will be collected continually as a part of the LTER program. The litterfall will be segregated by species and type of tissue, dried, weighed and archived.

(g) Instream photosynthesis. The scientific value of setting out to produce a long term data set that includes photosynthesis and respiration in a prairie stream will test hypotheses arising from pre-existing observations and theory. The current literature in stream ecology as exemplified by Cummins, 1974; Hynes, 1963; Fisher and Likens, 1973 leads to the conclusion that headwater streams are heterotrophic systems and that instream primary production is rarely the dominant organic matter input. This generality has recently been challenged by Minshall (1978) who used examples of several natural streams in which net annual production exceeded allochthonous inputs. This may occur where watershed organic matter production is limited or not shed, as in deserts or grasslands; or where stream courses are not shaded by canopy coverage; or both. We are presently investigating instream production in open canopy grassland reaches

of Kings Creek to compare with canopy covered reaches in the gallery forest of the same stream. The results of this study will provide a basis for identifying sites and appropriate sampling intervals where and when long term measurements of a comparative nature can be made.

We intend to use a modification of a chamber technique (Bott, et al. 1978) wherein trays of natural substrate are permanently installed in the stream bottom and chamber tops periodically attached for 48-72 hour periods to record diurnal oxygen oscillation. From these data, collected as paired samples in open and canopy covered stream reaches, in various seasons a long term comparison can emerge.

2) Dynamics of Populations of Organisms Selected to Represent Trophic Structure.

(h) Grasshoppers

Grasshoppers (Orthoptera - Acrididae) are important herbivores of vegetation throughout the midwestern United States. They are economically important in cultivated crops and rangeland consuming from 2.5% of available foliage under enphytotic conditions to 100% of available foliage under epiphytotic conditions (Weigert 1965).

Grasshoppers may also play an important role in energy flow (especially as prey for birds and other predators) within grassland ecosystems (Gangwere et al. 1976, Isley 1938).

The Flint Hills region of Kansas, i.e., Konza Prairie, provides a unique opportunity to study grasshoppers over long time periods. The grasshopper fauna consists of 50-60 species, ca. 25 of which are abundant. Four of these species Phoetaliotes nebrascaensis (Thomas), Orphulella speciosa (Scudder), Syrbula admirabilis (Uhler), and Mermiria maculipennis (Bruner) feed on big bluestem, little bluestem, and indiangrass (Cambell et al. 1974) and they are commonly found on Tulley and Florence soil types. Nymphs and adults of P. nebrascensis occur June-August and August-October; O. speciosa nymphs May-July and adults July-September; S. admirabilis nymphs June-July and adults July-September; M. maculipennis nymphs May-July and adults July-September (Smith and Knutson, unpublished data).

Three sampling techniques (vacuum-net sample, net sample, and night-cage sample) will be compared to select the best technique. It is essential that the insects collected by the technique selected, be stored for future references. A stratified-random sampling universe will be delineated in 2 replications of each of the following treatments: burned and grazed, burned and ungrazed, unburned and grazed, and unburned and ungrazed. A sampling universe will consist of 30 strata x 100 M (1 stratum = 10 M x 100 M). Each stratum will be sampled with one of the sampling techniques. The sampling techniques will be randomized across the strata within a sampling universe. Samples will be taken biweekly from June to September during the first two years of the study.

The vacuum-net sample will consist of a cone (base = .093 m^2) attached to a 3 M pole with a connecting hose to a DeVac^R (gasoline-powered vacuum net). The sampler will vacuum insects 3 times within an area to obtain one sample. The net sample will be similar to the vacuum-net sample. An insect aerial-net (0.93 m^2 base with a deep bag) will be fitted on a 9 M pole. The end of the bag will have a draw-sleeve. The net will be rapidly placed over a sample-site and

the insects vacuumed out with the DeVac. For the night-cage sample, cages (2 m x 2 m x 4 m) will be placed over the appropriate site during the night. The cages will be vacuumed the following morning with the DeVac.

Sampling precision curves and grasshopper dispersion patterns will be calculated according to Iwao and Kuno (1968) and Iwao (1968). The cost effectiveness of each technique will be compared using Relative Net Precision (Southwood 1966). The sampling techniques will be evaluated for any bias associated with the burning/grazing treatments.

From this study an adequate sampling technique for grasshoppers will be developed during the first two years of the grant. This sampling technique will be used for long-term data aquisition in the subsequent years of the grant.

(i) Mammals

The populations of three species of herbivorous rodents will be measured: Eastern Wood rat (Neotoma floridana), cotton rat (Sigmodon hispidus) and prairie vole (Microtus ochrogaster). Neotoma occurs along the brushy draws in the upper Kings Creek drainage and in the dogwood thickets of limestone outcrops. Since it does not experience cyclic changes in its population size from year to year, its population may be most closely related to primary production than the other two species. The size of the population will be indexed by counts of active nests during the winter along permanent transects.

Sigmodon and Microtus, unlike Neotoma, are restricted to the open prairie. These species will be censused in the fall and spring on permanent grids by removal trapping (see French et al, 1971 for a discussion of various trapping methods), using the Hansson (1969) estimation for population size. Sigmodon does not experience the large annual fluctuations in population size that Microtus does and thus, like Neotoma, might be better correlated with differences in primary productivity from one year to the next. A number of excellent demographic and nutritional studies have been conducted on Sigmodon (Baker, 1971; Cameron, 1977; Goetz, 1964; Joule and Cameron, 1974; McIntire et al., 1944; Randolph et al., 1977 to name a few).

Microtus is certainly the most common of the three on Konza Prairie, but does experience major cyclic population changes. But since this species will be captured along with Sigmodon in the trapping grid and since there is a recent, extensive study of the population of this species in Kansas (Gaines and Rose 1976) to use for comparison in the inital years of monitoring, the data on this species will be economical to obtain and worthwhile to analyze.

(j) Bird populations

The Emlen strip census (Emlen 1971, 1972) is widely used as a measure of bird populations, particularly in specific habitats of relatively small expanse or in areas not adjacent to roads for which a Fish and Wildlife Service Breeding-bird Survey (Robbins, and Van Velzen 1969) is not appropriate. Althought the Emlen method cannot generate absolute measures of population size as once hoped (Zimmerman

1977), it is still an excellent, easily used method for someone familiar with the local avifauna and produces a relative measure of diversity and density in the avian community.

Since 1972 bird populations on a unburned tract of 13 ha and an annually burned tract of 9 ha of the Konza Prairie Research Natural Area have been measured. These data demonstrate some apparent differences in the bird populations of these two habitats. The annually burned habitat has a lower number of species (mode = 7 species as opposed to a mode of 9 species on the unburned site), and a lower density (2.4 males/ha as opposed to 2.9 males/ha on the unburned site). Furthermore certain species are restricted in their distribution to the more mesic unburned site (e.g.- Common Yellowthroat, Henslow's Sparrow). As grazing treatments are established two additional transects will be added to provide grazed-burned and grazed-unburned to the design.

In addition to continuing the measurement of bird populations in these two habitats, two additional transects will be permanently set up along Kings Creek - one in the forest along the main stem of the creek and the other along one of the main upper branches beyond the cover of the gallery forest. Although we do have some measures of winter bird populations on the two prairie sites, most of the data are from the breeding season. We propose to regularly sample all four transects both winter (January - February) and summer (May-July).

While it is quite clear that birds play an insignificant role in the energy flow of the grassland ecosystem (Wiens 1973), it is nevertheless suggested that their populations may reflect irruptions of certain prey populations (e.g.-grasshoppers, voles) and hence reflect system responses to these natural "disturbances". It is also clear that a long-term record of bird species diversity and density would be a useful reference for investigators concerned with species-centered or trophic-related research problems.

(k) Greater Prairie Chicken

The largest Year-round resident bird of the tallgrass prairie is the greater prairie chicken, Tympanuchus cupido pinnatus (Costello 1969). This bird evolved in the prairie grassland of North America and its distribution is limited to tallgrass prairies (Aldrich 1963, Schwartz 1945, Baker 1953). Because of this and the fact that viable greater prairie chicken populations reflect the condition of the tallgrass habitat (Jones 1963, Kirsch 1974, Robel et al. 1970, Westemeier 1977), the greater prairie chicken has been selected as an organism for long-term research on KPRNA. Greater prairie chickens were selected specifically because of: (1) their unique association with the tallgrass prairie, (2) the considerable body of habitat-related research data compiled for this species, and (3) the availability of annual population survey data from Kansas and other prairie states for comparative purposes.

An annual index to spring prairie chicken populations will be determined from counts of males on all booming grounds (breeding display areas of males) on KPRNA. We presently know of eight such areas, shown by PC on overlay VII. Counts will be conducted at sunrise each spring on or about 1 and 30 March and 30 April to compensate for potential time-related changes in the number of males displaying on the spring booming grounds (Robel 1970). The potential population regulatory role of these

display areas is well documented (Robel 1972, Ballard and Robel 1974, Robel and Ballard 1974). These survey data will be comparable to statewide data collected annually in Kansas (Horak 1979), Missouri (Christisen 1969, 1979), Nebraska (Sisson 1976), and Colorado (Evans 1973). Additionally, prairie chickens will be trapped on lowland feeding areas on KPRNA each January. Cannon nets (Silvy and Robel 1968) and funnel traps (Ammann 1957) will be used to capture wintering prairie chickens. The sex and age of these trapped birds will be determined from plumage characteristics (Ammann 1944, Henderson et al. 1967); the resulting age ratio data will be used as an index to annual production while the sex ratio data will assist in estimating population levels from spring booming ground counts of males. All captured birds will be leg banded and released. Recapture data will be used to estimate annual mortality and survival in the prairie chicken population as per Hickey (1952) and Robel et al. (1972).

At the two of the eight booming grounds, observations will be made each spring to detect any changes in behavioral patterns which might be population-related. Territory sizes of individual males will be determined and mating success tallied as per Robel (1966). These parameters reflect aggressive behavior and social dominance, both of which have been proposed to be associated with long-term population fluctuations in tetraonids (Wellington 1960, Watson and Moss 1970, Robel 1972, Bowman and Robel 1977, Moss et al. 1979)

Our proposed long-term studies of prairie chickens will provide a data set for tetraonids in North America comparable to the classic tetraonid studies of Jenkins et al. (1963), Watson (1965), and Watson and Moss (1972) in Scotland.

(1) Phenological Records

The history of phenological records and the rationale for collecting them have been presented by various authors in the volume edited by Lieth (1974) and specifically for grasslands by French and Aquer. The value of phenological records is best realized when they may be correlated with local meterological data, when they are collected for the same species over a wide geographical range (a network level problem), and when there are records for species representing different trophic levels at the same site. Long term studies with records of the type mentioned above may be used to address basic questions of seasonality:

1) the relation between phenology and local climate
2) the geographical responses of species to climate
3) the phenology of interactions between species and trophic levels.

Phenological data exists on the date of first flowering for some 160 species over a 30 year period at Manhattan (Hulbert, 1963). Hulbert (ibid.) has also reported several other scattered and short term phenological records for the area. Phenological records are not being maintained by either the Soil Conservation Service's Plant Materials Center or by the Agricultural Experimental Station with the exception of a few short term research projects. This area presently represents a gap in the geographical distribution of phenological recording sites. The current phenological records on Konza Prairie consist only of one year of detailed records of the density of stems in flower by date for most of the entomophilous flora, and five years of records on standing biomass by date.

Plant species. Phenological records of the three dominant grass species being analyzed in the permanent plots; big bluestem, little bluestem, and indiangrass will be made. These are all warm-season grasses which flower in the late summer and fall. These three species are the first obvious choices because they are dominants, geographically widespread, and other data are being collected on them. Temperature appears to be the dominant factor in determining the initiation of vegetative growth while soil moisture appears to be the dominant factor affecting the flowering phenophases. Heath aster (Aster ericoides L.) is an abundant forb which also blooms in late summer and fall. Two closely related legumes, Baptisia australis (L.) R. Br. and B. leucophaea Nutt., exhibit very early spring vegetative growth and flowering. The flowering of the two species overlaps but peak flowering is offset. By using both species we will have data on the degree to which late springs truncate the growing seasons as well as delaying it. Two woody species, hackberry (Celtis occidentalis L.) and chinquapin oak (Quercus prinoides Willd.), exist in the gallery forest and break dormancy at widely different dates.

The genotypes of Lonicera tartarica L. and L. Korolkowii Stapf. used by NOAA and the Purdue phenology gardens for phenological records will be planted at a site near the weather station.

The Phenological Records to Be Taken on Plants. We will begin with records on the initiation of vegetative growth and on the initiation and duration of flowering. For woody species this will be the opening of vegetative buds and of flower buds. The records of vegetation growth will include not only the first vegetative growth observed, but also the cumulative initiation of vegetative growth in the population of these species. Similarly the records on flowering will include the proportion of trees in flower by date.

For herbaceous plants the number of stems in flower and the initiation of above ground vegetative growth will be recorded. The standing biomass being collected will also be recorded by date and will constitute a part of the phenological record.

Sampling for Plant Phenological Data. The herbaceous plant species will be sampled adjacent to the plot sites on the burned and unburned areas. Because of wind and rain, it will not be possible to burn at constant phenological stages on calendar dates. Long term records will be necessary to accumulate enough data to separate the effects of precipitation, temperature and the burning. Two types of sampling will be used. Ten randomly selected plants of each species will be marked by stakes at each site. These plants will be observed every three days during the critical phenological periods and recorded as to whether or not they have entered the phenophase being studied. These ten plants will provide a genetically constant sample. The second type of sampling is a modification of the scheme used by Schemske et al. (1978). For the grasses, the number of vegetatively active shoots or the number of flowering stems for each of three species will be recorded for meter square plots every three days during the critical period. For the forbs, which are in lower density, transects will be used with the recorder walking a set distance on each transect for each species and counting the number of plants in the appropriate phenophase. The recorder will carry a 2 meter pole down the rope marked transect. The ends of the pole will mark the limit of the sampling area. The interval will be every three days during the critical times (i.e. we will not be taking records of Baptisia sp. during August).

One hundred randomly selected trees of each species will be marked along a transect in the gallery forest. Random in this section means a formal use of random numbers and selection procedure not merely a phrase meaning we will try not to bias the selection. As trees die they will be replaced by the same selection process, because genetic individuals are long lived and easily identified. The genetic variance between years will be zero or small. For this reason we can get good data from this small sample size. During the critical periods for phenophase change the tree transects will be recorded every other day. Phenophase status will be recorded by individual by date. The Lonicera species will be recorded for flowers first day of flowering and first day of vegetative bud opening.

We will begin with these two phenophase measurements on these plant species. We will add phenophases and species as they become important at the site or as a part of network consideration.

Insect Phenology. The four grasshopper species; Phoetaliotes nebrascaensis, Orphulella speciosa, Syrbula admirabilis, and Mermiria maculipennis, which will be sampled for population characteristics will also be measured for phenology. The individuals which are captured in the bi-weekly sampling will be measured for size and recorded as adults or nymphs. The size and stage will be recorded by date giving records on development at that date.

The Phenological Data Base. After several years of collection of phenological records the data base will include the raw records by date plus correlations with weather data and correlations between species and phenophases.

3) Pattern and Control of Organic Matter Accumulation in Surface Layers and Sediments

(m) Soil Cores

At KPRNA the focus of this measurement is to be on cores of the two most common of approximately nine soil types on the area. The deep soil is the Tully silty clay loam and the shallow is the Florence cherty silt loam. A long (150 cm) core will be taken from the Tully in 1980 at the site marked 2 on overlay VII. This site is burned three years running then left unburned for three years. Three composite shallow cores of these two soils will be collected from both soils from burned and unburned treatments, separated into an organic layer and the top centimeter of mineral soil. This will be done every three years, prior to burning manipulations. These sites are marked 1 on overlay VII. The long core site should be cored again in 1990 and at that time a decision about extending or shortening the time interval can be made.

The long cores will be done mechanically with state of art coring devices under the direction of O. W. Bidwell, Dept. of Agronomy. Short composite cores will be done by hand. The soils alalytical laboratory (D. H. Whitney) at KSU is willing and able to do full soil analysis, but until several network sites have selected common methods, or for 5-10 years, whichever comes first, we will archive these cores.

(n) Prairie litter fall. Understanding decomposition of organic material in grassland is proving to be one of the more difficult puzzles. There seems to be agreement, however, among prairie ecologists that below ground phenomena likely dominate the system. The choice of a repetitive measurement at relatively short intervals over the long term is difficult to make. The information to justify a complicated or energy expensive effort is not available. The effort of preparing, placing and recovering litter bags seems small enough, however, to warrant the risk; and the accumulation of such a data set will aid further investigation of decomposition.

Vegetation clippings will be weighed and placed in .25 m^2 nylon mesh bags at the end of the growing season. Subsamples will be dried and weighed. Replicate litter bags will be archived and/or placed on burned and unburned sites. The litter bags placed on burn treatments will be picked up quarterly and just prior to burning, dried, weighed and archived; those on unburned treatments will also be retrieved quarterly with some remaining in place for one year before drying weighing and archiving.

Analysis of archived samples shall await accumulation of several years of samples and the development of more intense and experimental investigation of the decomposition process, so that information from the effort is maxmized.

(o) Gallery forest litter fall and stream leaf-pac decomposition. The decomposition of gallery forest litter occurs on the forest floor and in the stream which serves as a trap for laterally transported coarse organic material. Litter from chinquapin oak, bur oak, hackberry and ash trees will be used in litter bag decomposition measurements. After abscission litter bags will be placed at the three sites where litter fall is to be collected. Replicate bags initally will be retrieved at quarterly intervals.

Leaf pacs of bur oak and hackberry (the dominant species at most stream sites; one fast decomposing and one slow) will be fabricated and placed in Kings Creek after abscission. Pacs will be recovered after two weeks and at 400 degree day intervals thereafter. The leaf pac residue will be dried, weighed and ashed.

(p) Peterson (1979) developed a coring-pumping device that allows estimation of total organic matter stored in the stream bed. Annual fluctuations of stored organic matter resulting from biotic input and decomposition processes are unknown but under investigation. Year to year or long term variation is likely tied to the magnitude and frequency of hydrologic events. Three sites where stream channel geometry will be measured and photographed annually in winter will also be cored to estimate this organic matter storage parameter. (Sites numbered four on overlay VII). The core samples will be size fractionated, dried, weighed and ashed.

4) Patterns of inorganic inputs and movements of nutrients through soils ground water and surface waters

(q) Methods as given in Field Observer instruction manual. National Atmospheric Deposition program will be followed (Anon. 1978b). The KPRNA site for collection marked M on the U.S.G.S. topographic sheet.

(r) Biesecker and Leifeste (1975) describe the U.S.G.S benchmark watershed network program. In brief it provides the following measures at the site identified on overlay IV.

Continuously monitor

Discharge
Water temperature
Specific conductance

Monthly

Alkalinity
Bicarbonate
Calcium
Chloride
Total dissolved solids
Fluoride
Magnesium
Potassium
Silica
Sodium
Sulfate
Turbidity (Jackson units)
Nitrogen (total organic, total, NH4, dissolved, suspended, NO2 + NO3)
Phosphorus (dissolved, total)
Coliform

Monthly plus storm events

Suspended sediment concentration and particle size
Total dissolved solids (residue after evaporation)

Feb., May, June, July, Aug., Sept., Nov.

Phytoplankton
Total organic carbon

Quarterly

Biomass (Periphyton)
Chlorophyll (A and B)
Metals, dissolved and suspended separately: Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Selenium, Silver, Zinc

Semi-annually

Bed material particle size
Gross Alpha count
Radium-226
Uranium
Gross Beta count
Pottassium-40

The survey has also installed a cableway which KPRNA staff may use. The U.S.G.S. office is in Lawrence, KS and we have had good cooperation with Paul R. Jordan (hydrologist).

(s) Geochemistry of Natural Waters in the Konza Prairie.

Springs occur in several limestone and dolomitic limestone units separated by shales in the main watershed of the Konza Prairie. The stratigraphic section is most of the Council Grove Group in the Gearyan Stage of the Lower Permian Series. Differences in the chemistry among the different springs in the Konza Prairie are controlled mainly by the presence of thin gypsum units or small amounts of gypsum nodules or crystals within the strata. Thus, sulfate concentration shows the greatest range in samples collected during the same hydrologic conditions. Variations in the concentrations of constituents in a spring are inversely correlated with its discharge (Whittemore and Switek 1977).

The chemistry of the baseflow in the main stream largely reflects a mixture of the spring waters in the watershed. Flows from the two springs of highest sulfate concentration are small relative to flows from springs in the Crouse Limestone, Neva Limestone Member, and Burr Limestone Member, hence their smaller influence on the water chemistry. Higher nitrate concentrations in the spring waters from the Burr Limestone Member and the stream water is an observation of considerable interest that needs explanation.

The general chemical character of stream and ground waters in the Konza Prairie are due principally to the relatively soluble carbonate bedrock of the Konza Prairie. Concentrations of calcium, magnesium, and bicarbonate are more than an order of magnitude greater, sodium and sulfate are several times to nearly an order of magnitude more, potassium and chloride a few times and dissolved silica about twice great the prairie as in the better known Hubbard Brook Forest waters. Dissolved nitrate concentrations are similar. Donald Whittemore of the Kansas Geological Survey has conducted preliminary investigations into the chemistry of ground water at KPRNA. He is continuing and will perform all inorganic chemical analyses for KPRNA waters (see also below). Identification of an informative long term measure of ground water chemical parameters awaits better information. A decision can be reached during the tenure of this project, and at minimal cost to the project (i.e. logistic support).

(t) The information acquired by the U.S.G.S program (q above) will provide useful information about low flow chemistry and hydrology of Kings Creek surface flow. Substantial fluctuations are expected to accompany individual storm events which are a feature of the prairie climate. We expect that these events will be significant causes of material export from the watershed. This should be investigated in detail over a long time period, because the range of discharge magnitude is great (from zero following a precipitation event because no runoff occurred; to discharge estimated to be 400 m^3/sec after a general 10 cm rain during a ten hour period after the watershed was saturated).

The Kansas Geological Survey is installing proportional sampling apparatus at the U.S.G.S. site this spring and will conduct the analysis of the resulting samples.

(u) Ground water level, movement and chemistry is a component of the system of which we have substantial ignorance. There are three wells associated with windmills in the Kings Creek Watershed that offer the

possibility to measure ground water level. (see "w" on overlay IV.) This measure will be made monthly at these sites for five or so years or until a decision to change the interval or drill other wells is defensible.

5) Patterns and frequency of disturbance

(v) Meteorological data are necessary as correlates of long term variability in most of the ecological parameters to be investigated in this program. Furthermore, the dominant aperiodic disturbances (with the possible exception of fire) are weather related in this mid-continent climate. Thunderstorms, often accompanied by high winds, heavy rainfall and hail are a common feature of the region. Drought also can be a significant disturbance of biological activity. Providing an on-site record of these weather events is, then, a necessary part of our proposed effort.

There are two facilities of the Kansas Agricultural Experiment Station available to scientists at KPRNA to mention at this point.

The Weather Data Library contains the most extensive file of Kansas weather records in the state. There are over 400 locations in the state at which precipitation measurments are taken and at 150 of these temperature extremes also are recorded. Many of these stations have been in operation for 50 years or more, so that the amount of the data available is very large. In 1956, the Kansas station joined other experiment stations in the North Central region in a project to place these records in computer-compatible form so that the large volume of data could be summarized. The arrival of computers on the research scene made it possible to expand the definition of climate beyond the usual "average weather." The National Weather Service located its State Climatology program at Manhattan from 1964 to 1973. When the program was cut in an economy move, the data files of that office were donated to the Weather Data Library.

At the present time, the data are stored on magnetic tapes that requires weather data. Data for selected stations go back to 1900. All records taken after August, 1948, are on tape, which provides a 30-year record. Most stations record only precipitation. Some provide temperature extremes, and only a few of the first-order National Weather Service and Flight Service Stations take complete weather observations.

In addition to the data file, the Weather Data Library provides a consulting service for those who need help in incorporating weather relationships in their research. Dean Bark, Climatologist for the Agricultural Experiment Station, has the responsibility and will aid in the location, design, installation and operation of the KPRNA meteorological station. The station located on the KSU campus (ca ten kilometers away from KPRNA) will serve as an additional source of weather information, and a source of spare equipment in the event of failure.

The evapotranspiration laboratory maintains a twenty acre research site near KPRNA (L on Figure 1.) with two weighing lysimeters and a weather station which collects a continuous record of global shortwave radiation, wind speed, wind direction, relative humidity and soil temperature at ca. fifteen centimeters in floodplain soil. This facility in the Kansas River floodplain, along with the one on the campus and one at KPRNA, in effect provide a rough transect across the Kansas River valley.

The location of the KPRNA meteorological station is identified by on overlay VII. Sensors and associated instrumentation as stand

ardized among other sites will be installed on a tower at mid slope appropiately above the canopy. Guidance for the purchase of sensors has been taken from the TIE Guidance Document (Anon. 1979b).

We intend that this facility will be tended daily so that sensor "read out" can be visually monitored, solar sensors cleaned etc. Output from the sensors will be stored in digital form on a multichannel data logger in the instrument shelter. The potential exists for this interim storage system to be polled by phone from the KSU central computer on the campus to transfer data to appropriate subroutines for storage on tapes or discs, printing and plotting periodic summaries etc. We feel that this capacity is potentially desirable but we prefer to wait until network decisions vis-a-vis data storage and retrieval are made before these data handling systems are developed here. The interim mechanism will involve cassette tape storage from the on site data logger. Cassettes can be transcribed to mag tape storage at, say, monthly intervals after hand carrying to the campus facility. This is not inconvenient and it makes sense to await network coordination for a few years at least.

Our intention is to install a single complement of instrumentation and further consider the wisdom of redundancy with investigators with different experience when the inital network is established.

The continuous measures to be made at the KPRNA site are: global shortwave radiation (direct plus diffuse) air temperature, dew point, wind direction and wind speed at standard height, soil temperature (on small plots; burned and unburned; at five and thirty centimeters below the surface) and precipitation.

The scale of spatial variation of precipitation is finer that the distribution of LTER measurement sites on KPRNA. Thus, in spite of a precise record of precipitation at the above meteorological site, the likelihood that the record will be an inaccurate record of the precipiation on KPRNA is too high for useful correlation. Remote rain gages will, therefore be placed near all LTER-I sites marked "R" on overlay VII and at sites in the Kings Creek watershed.

Soil moisture will be measured every two weeks at each LTER-1 site with a neutron probe. Access tubes will be placed two meters deep in Tully soil (The deep and non-rocky prairie soil) and at least one meter deep in the Florence soil (the shallow rocky soil).

Atmospheric gas concentrations

The atmosphere at KPRNA, located near mid continent, is dominated in the summer by air masses from the Gulf of Mexico and in the winter by air masses from the Arctic. Population densities are relatively low and industrial centers are relatively distant and leeward. The atmosphere may be as free of fossil fuel effluents as is currently available for long term measurement at inland sites.

The effects on local ecosystem processes of recent increases in the concentrations of CO_2, SO_2, NO_3 and O_3 resulting from human activity seem less likely to be detectable at KPRNA, i.e. atmospheric gas concentration is not a likely correlate of the variation in ecosystem processes. It may prove useful to initiate measurements as soon as practical, however, so that the baseline is established. There are, at this time, no sites in rural Kansas where these data are being collected.

The only continuous air quality monitoring sites being operated by the Kansas Department of Health and Environment are located in the

urban areas of Wichita, Topeka and Kansas City. NO_x or CO_2 is not measured anywhere in the state. SO_2 only is measured at Kansas City and O_3 only at Wichita and Kansas City. The Kansas Department of Health and Environment conducted remote measurements of NO_x and O_3 in rural areas from 1970 to 1977. Concentrations were below detection or standards and the sites were discontinued. Total particulates are measured continuously at six sites in Kansas; Dodge City and Goodland (in western Kansas) Concordia and Wichita (in central Kansas) and Topeka and Kansas City (in eastern Kansas). These data are available from 1970 to the present from EPA. (J. Sides, KDHE, personal communication)

Network objectives will be well served by including a site at mid continent with concentrations of these gases at the low end of the array of spatial variation. It is primarily with network objectives in mind that we suggest the need for continuous measurement of these atmospheric gases at KPRNA. It is important that network objectives and methods be coordinated early in the program.

The instrumentation and sampling systems can be constructed with the advise of Clifton E. Meloan and Wm. R. Fately in the KSU Department of Chemistry, both of whom are supported by the KAES. Costs to NSF can be further suppressed because the glass elements system can be constructed by Mitsugi Ohno, an exceptionally talented glass blower supported by KAES.

The instrumentation will be housed in the main building in the headquarters building where daily attention is feasible, (overlay V) and the sampler is within a few meters of the site of meteorological measurement.

6) Data storage and retrieval system

We feel that considerable support for the development of the data storage and retrieval system should come from a network coordination group. The independent development of a data storage and retrieval system at each site would not be cost effective and would make comparative studies between sites more difficult, if not impossible. We have selected an interim system for KPRNA which alleviates, at least in part, the problems of the lack of a network system. We will use the Statistical Package for the Social Sciences (SPSS), Nie et al. (1975). This system is already developed and is available at most universities and research institutes. Data files produced here will be readily accessible to other LTER sites or individual investigators on magnetic tapes. These data can then be retrieved or analyzed at any computing center supporting SPSS. SPSS also has the following important advantages:

1. It has excellent file creation, access, and modification facilities.
2. It has report writing facilities.
3. Files easily can be merged.
4. Descriptions of variables and measurement techniques may be included in the data files.
5. There are good statistical routines in SPSS.
6. SPSS files can be read by the more sophisticated SAS statistical package.
7. SPSS is supported by the systems staff and a full time statistical consultant at the KSU Computing Center.
8. Magnetic tapes with SPSS files compatible with most other computers can be produced at the KSU Computing Center using IBM and local utility programs.

9. Two of the Konza Prairie staff have extensive experience with SPSS.
10. Most of the extensive data sets which now exist for Konza Prairie are already in SPSS files.

LTER data will be collected on forms prepared for direct keypunching. These data will be transferred to punched cards by the KSU Computing Center keypunch operators and/or LTER staff. From cards they will be transferred to SPSS files on magnetic tapes. These files will be available to other sites or to individual scientists for the cost of the magnetic tapes and copy charges. Individual scientists working KPRNA will be encouraged to submit their own data to the data base as SPSS files. LTER data collected by automated recording devices will be copied from the recording medium to SPSS files using existing facilities on campus. There are a large number of micro-and minicomputer systems at KSU capable of reading a wide variety of recording devices. Cooperation in the use of this equipment has been excellent and is facilitated by a well organized campus users group established to support such cooperation.

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VII. Personnel

There are eight faculty and staff members of the Division of Biology (all of whom are appointed through the Kansas Agricultural Experiment Station) and one other KAES faculty (in entomology) whose vitae are attached because of their involvement in the design of this proposal and the subsequent training of the technical staff. Faculty members in agronomy, physics and geology, are mentioned in the proposal because of their investigations on KPRNA and the use of KAES analytical labs under their direction.

The faculty involvement is aimed at design of the long term data collection protocols, training of technical staff to make the proposed measurements and, as the data set develops, interpretation, summarization and publication of results. Interpretation of long term data sets will involve, in several cases, further experimental investigation. This will stimulate additional research for faculty, graduate students and visiting investigators.

For the purposes of this proposal the following table provides a resumé of faculty involvement. The outline of LTER measurement on page 28 identifies areas of faculty responsibility with their initials. Those identified with asterisks are partially funded in this proposal. The rest represent KSU contriubtion or an Agriculture Experiment Station service function.

Name	Title & Dept.	LTER responsibility
G. R. Marzolf*	Prof. of Biology	Coordination & progress reporting; stream measurements NADP, decomposition
J. L. Zimmerman*	Prof. of Biology	Vertebrate measurements
L. C. Hulbert	Prof. of Biology (Director KPRNA)	Primary production, vegetation mapping, soil cores
M. P. Johnson*	Assoc. Prof. of Biology (Assoc. Dir. KPRNA)	Data storage & retrieval, phenology
R. J. Robel	Prof. of Biology	prairie chicken measurements
T. M. Barkley	Prof. of Biology	plant taxonomy, archiving, curator of herbarium
F. L. Poston	Asst. Prof. of Entomology	grasshopper measurements
L. D. Bark	Prof. of Physics	meteorology
C. E. Meloan	Prof. of Analytical Chemistry	atmospheric gases

Six technicians are to be supported with NSF funding, two are already supported by KAES. These eight people will comprise the LTER work force under the direction of the P.I., (Marzolf) and the Director of Konza Prairie (Hulbert). They will be under the continual tutelage and guidance of Kansas Agricultural Experiment Station faculty with appropriate expertise.

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