

acres are underlain with coal which is a major power reserve. There are major proposals to transport water from Lake Sakakawea to potential minemouth generator sites and to irrigate land. The Little Missouri River has been proposed as a candidate for formal classification as a Scenic River. Organizations have requested that wilderness or open space values be classified. There are accelerating interests in tourism and historical sites. Archeologists have made significant discoveries here. Snowmobile use has tripled in two years, as well as increasing use by motorcycles, horseback riders and hunters. Furthermore, the existence and needs of the livestock industry cannot be forgotten in the press to deal somehow with these other values and demands. More than 610 rancher-permittees now graze 77,000 cattle on the National Grasslands of North Dakota. They have had a long-term share in the battle to reclaim and manage these lands properly.

Many of these uses can be quite compatible or complimentary if they are properly planned and integrated. With the endorsement of the Governor, North Dakota State University has obtained funds for, and is underway on, Phase I of a three-phase study of the nine southwestern counties of the State, which in-

clude the Little Missouri National Grasslands. Phase I is tentatively scheduled for completion in about 16 months. Another significant part of the planning effort related to the National Grasslands is the Multiple Use Plan being prepared by the Forest Service. Part I, covering the whole area, is being revised to incorporate public comments to the draft copy. Part II will be specific plans for high priority parts of the area.

The Environmental Protection Act requires Federal administrators to evaluate proposed activities on Federal lands for major impacts to the quality of the environment. This sets the stage for either modification, approval, or disapproval of any proposals of a controversial nature.

With a staff basically designed and financed for a grazing economy, and with the speeding confluence of demands apparent, the Forest Service should not commit the land to any further major encumbrances or new impacts now. The study and response from the people will indicate needs and areas of relative suitability or nonsuitability for various types of development. Public comment is invited as an essential part of this effort.

MANAGEMENT OF KONZA PRAIRIE TO APPROXIMATE PRE-WHITE-MAN FIRE INFLUENCES*

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Abstract. Konza Prairie Research Natural Area, 916 acres (370.9 hectares) of unplowed native bluestem prairie, 10 miles south of Manhattan, Kansas, was purchased in 1971 by The Nature Conservancy and given to the Kansas State University Endowment Association for ecological research. The objective of management is to approximate the pre-white-man prairie ecosystem. Fires in that system were caused by lightning and Indians. Although lightning occurs primarily during the growing season, lightning storms have been recorded every month of the year. Spring has a slightly higher incidence of lightning than autumn.

A burning plan has been developed for Konza Prairie with four replications of six treatments: unburned, burned in late April at 1-, 2-, 4-, and 10-year intervals, and burned after years when precipitation was at least 1.2 times the median. These treatments include the possible range of fire occurrence in pre-white-man times, so they should allow us to assess both the ways that fire affects prairie and the frequencies that result in perpetuating prairie in good condition.

Part of my previous research has been designed to ascertain the differences in composition of bluestem prairie according to treatment and soil. To help assess treatments, it seemed important to know what the original and the undisturbed composition would be on each soil. By much searching for suitable sites I did find some unused spots, mostly where a road had gone around a steep hill but the fence went straight, leaving a small area up to a few acres ungrazed. Such areas were burned unpredictably, and were always on steep rocky soils. It was eight years before I found an ungrazed, unmowed, and rarely burned area on deep soils—a double fenced section line that had long ago been abandoned for a roadway with fences intact and owners who did not burn the adjacent range. After one year's

study, I found that a herd of cattle had been trailed down it in the spring when the soil was unusually soft and wet.

Clearly we needed a natural area for ecological research on the bluestem prairie. Efforts to secure one began about 1957 when a group from several departments of Arts and Sciences and Agriculture drew up a report citing the need and asking the administration for help. The effort intensified about 10 years later, and a thorough inventory of possible sites in an area within 30 to 50 miles of Manhattan was made. The criteria desired in an area were:

1. Biota as natural as possible. Available areas never plowed and moderately stocked were examined to see how well they met the other criteria.
2. Soils of agricultural quality in addition to steep, rocky soils
3. Large enough to support small animals in natural conditions
4. Close enough to KSU to facilitate research.

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The second criterion gave the most difficulty. Large unplowed acreages existed in the Flint Hills because they were too steep or rocky to plow, but generally any area that was plowable had been plowed. We finally found a few rare areas that had some patches of unplowed agricultural soils, then checked ownership and negotiated for acquisition. For a long period it seemed hopeless.

Finally through the efforts of many people in the KSU administration and in The Nature Conservancy, we secured a 915-acre (370.9-hectare) tract that met these criteria rather well. The Nature Conservancy purchased the area in December, 1971, using funds generously donated by Miss Katharine Ordway, whereby the area became another unit in the Ordway Prairie Preserve System. The Nature Conservancy immediately transferred title to the KSU Endowment Association for use in ecological research.

Because the donor asked that we use an Indian name, we chose to name the area after the tribe that inhabited the area well before it was disturbed by white men. This also is the tribe from which the state of Kansas derived its name. Using "Kansas Prairie" would have implied a state-owned prairie, rather than an Indian name, so we chose Konza (short o), one of the 50 variants of the spelling of the tribe.

KONZA PRAIRIE RESEARCH NATURAL AREA

One of the differences between Konza Prairie and most natural areas is that it was selected to be representative of the widely occurring bluestem prairie, whereas many natural areas are (properly) selected and preserved because they are unique or unusual. We need the characteristic as well as the unusual areas for scientific study.

Konza Prairie Research Natural Area, 10 miles south of KSU, can be reached in 20 minutes from the campus (Fig. 1). It is about 3 miles long by one-half mile wide (0.8 by 4.8 km) in the north edge of Geary County, Kansas. Management is designed to reestablish as closely as possible the pre-white-man bluestem prairie ecosystem, because that will give us a chance to evaluate the changes man has induced by his manipulations, and because study of the natural, self-sustaining ecosystem can help us learn principles concerning the functioning of the many parts of a stable system. The climate, topography, soils, and most of the native biota are there, and nothing need be done concerning them to reestablish the original prairie. However, leaving the area alone will not satisfactorily reestablish the original prairie because the large herbivores, bison, elk, and antelope formerly present are absent, and because fire would rarely occur naturally.

Reintroduction of large native herbivores was rejected because the area is too small for such animals to move around in even a semblance of their natural state. It was deemed better to exclude all large herbivores and to make comparisons with the experimental cattle-grazed ranges owned by KSU to evaluate grazing influences.

FIRE IN PRESETTLEMENT PRAIRIES

That fire was a part of the original prairie is attested by records of early naturalists and explorers, and by studies on the vegetation of prairie areas unburned for long periods. Bragg (1971) documented forest invasion of prairie in Geary County, Kansas, by using U.S. Land Office Survey records made in 1856 and 1857 and U.S. Department of Agriculture aerial photographs made from 1937 to 1969. The surveyors in 1856 and 1857 recorded when they entered and left timber on section and township lines, and they used trees as witnesses for survey markers. Using those sources of information Bragg found no detectable difference in the amount of area in forest today and in 1857 on bluestem ranges regularly burned, but he found marked increases (up to nearly continuous forest) on some soils that had not been burned for many years.

Clearly then we need to burn Konza Prairie to approximate the original conditions. We know that the American Indian and

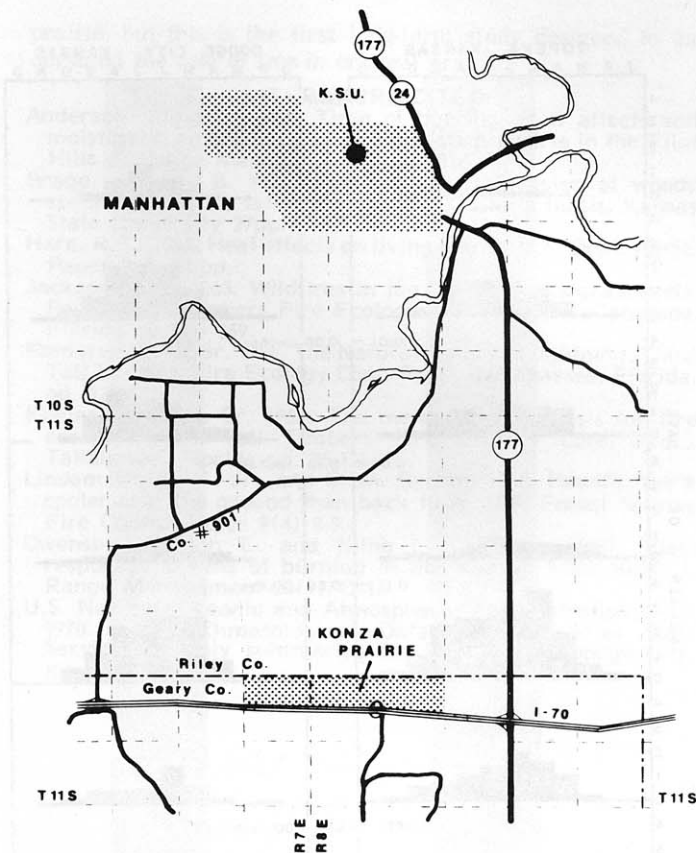


Fig. 1. Konza Prairie, 916 acres of unplowed bluestem prairie, ten miles south of Kansas State University.

lightning (Komarek 1964, 1966, Jackson 1965) started fires in the prairie, but we do not know how often, at what season, or how erratically fires occurred. No records have been kept in the grassland of the occurrence of lightning-caused fires, as the U.S. Forest Service has done in forests. To get some indication of the likelihood of lightning-caused fires, records of thunder were compiled from daily weather records of first-order weather stations where the occurrence of thunder as well as the amount of precipitation was recorded. (Visible lightning was also recorded for a number of years, but since lightning can be seen for long distances, those records were not used) (U.S. NOAA 1951-1970).

Obviously the chance of lightning starting a grass fire is inversely related to the amount of accompanying rain. Unfortunately the weather records do not record the amount of precipitation where the lightning occurred, because thunder can be heard for five or more miles from the place the precipitation was recorded. The data can be used only as a rough indication of the likelihood of lightning-caused grass fires, but the number of thunderstorms with no rain, a trace, or less than 0.05 inch of precipitation makes it reasonable to expect that thunderstorms occurred each year with so little rain that a grass fire could have resulted when the grass was dry enough to burn (Fig. 2). Most years prairie grasses start active growth about the end of April. If standing-dead grass is small compared with green growth, a fire is unlikely by early May; but if standing dead is great, a fire can occur for at least a month after new growth starts. Grass may become dry enough to burn as early as sometime in August in dry years and as late as late September in wet years. Lightning-caused fires could occur anytime from about September through early May, but the likelihood would be much higher in autumn and spring, with spring appearing to have a higher probability than autumn because of the more frequent thunderstorms.

BURNING PLAN

The burning plan developed for Konza Prairie encompasses the range of burning frequencies possible in pre-white-man times, from unburned to burned every year (Fig. 3). Unburned areas are expected to become forested; and in those areas we will study the rate of invasion by each species. We are interested to learn if 4- and 10-year intervals between fires will keep out woody plants, as well as learning effects of those intervals on herbaceous species. Burning after years when precipitation was at least 1.2 times the median probably will be more like the original than burning at uniform intervals. Precipitation records at Manhattan for the last 100 years indicate that precipitation is at least 1.2 times normal about one year in four. The interval between such years varied from 1 to 18.

This plan will allow us to ascertain which burning treatments allow the prairie to persist and which ones do not, thereby helping us to understand the likely fire frequency before European man settled the area. Also, by comparing various treatments, we will gain considerable information on the way that fire affects grassland. A deficiency of the plan is lack of burning at other times in the year, so we expect to add some small plots burned in autumn and early spring. We also intend to add some small plots burned with the wind and others burned against the wind, because the effects differ (Lindemuth and Byram 1948, Hare 1961).

For this plan to succeed we must successfully control our prescribed burns and prevent wild fire from occurring, at least on most of the area. Fire fighting equipment is being procured, and efforts are underway to obtain funds to build a headquarters part of which will include quarters for a caretaker, one of whose duties will be fire detection and control. We plan to mow a wide strip, perhaps 25 meters wide, in late July around the periphery of the area, and to mow some strips through the area. In the strips fires can be more readily stopped than where unmowed. Experience indicates the need, we will burn a narrow band perhaps 2 meters wide, within the mowed strips each autumn making an effective fire barrier. In addition to being an aid in fire control, mowing in late July is a desired treatment, as it results in favorable conditions for many prairie species. We will use a sickle bar mower on the nonrocky soil, but something like a flail mower on the rocky sites. Where a sickle-bar is used, we plan to remove the cut grass for hay on half the area and leave it on the other half. After a number of years, we may be able to assess the change in fertility due to removal of nutrients in the hay.

Results of fire studies on Konza Prairie will have many applications. For example, the results will be useful in managing a

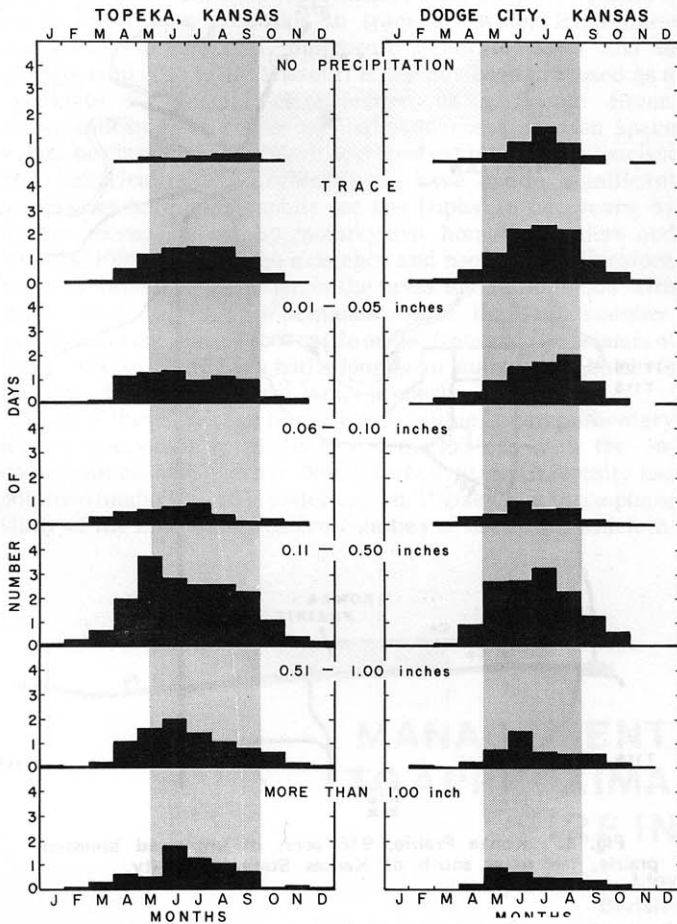


Fig. 2. Seasonal occurrence of thunderstorms associated with various amounts of precipitation at Topeka and Dodge City, Kansas, from 1951 through 1970.

With evidence that April would be as likely or more likely than other times for lightning-caused fires, and with the evidence that late-spring burning results in higher grass yields than earlier burning does (Anderson 1965, Owensby and Anderson 1967), we decided that the main time for burning should be spring, preferably late April.

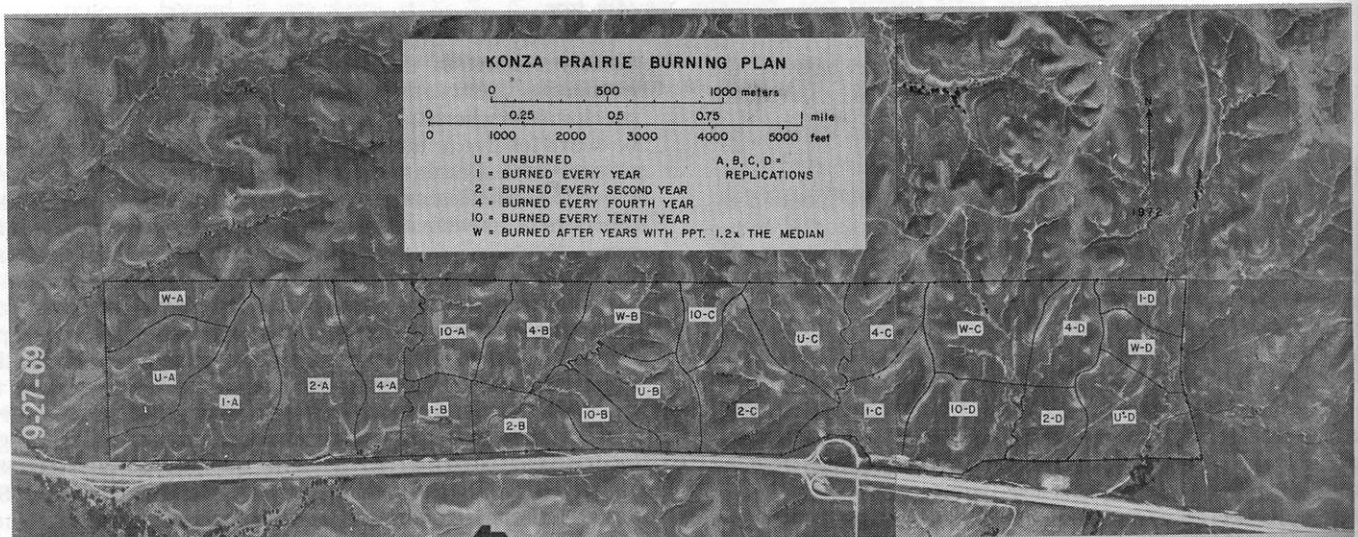


Fig. 3. Konza Prairie burning plan. The four replications of six treatments occupy small watersheds as much as possible, so that nutrient and soil losses in runoff may be measured.

prairie national park. Opponents of a prairie national park have used the threat of fire to park visitors and to adjacent property as reasons for not having such a park. Results on Konza Prairie should help evaluate those objections. It appears that use of procedures outlined for Konza Prairie will be applicable in a park also. For example, mowing a wide strip around the periphery should make the threat to adjacent property no greater than at present, and it would be possible to burn a narrow strip each autumn within the mowed area to further reduce the threat of fire to adjacent property to less than under present grazing management. Along roads, visitor centers, and campsites, mowing annually would effectively remove fire as a serious threat to people in those locations. A prairie national park should have large native herbivores like bison, so the grassland would be grazed appreciably, although probably less intensely than ranches grazed by domestic livestock. Deciding how often a prairie national park should be burned will be greatly helped by the results on Konza Prairie. If a part of the park is burned each year, herbivores will graze mostly on the burned area, resulting in rotation of the area grazed. If the stocking rate is reasonable that might be good management.

We hope Konza Prairie can be a stimulus for long-range plans for other areas. Certainly the value of the area will increase proportionately to the length of the time the treatments are continued. Other studies of fire have been made in bluestem

prairie, but this is the first long-term study designed to understand the role of fire in original prairie.

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APPROXIMATING PRE-WHITE-MAN ANIMAL INFLUENCES AND RELATIONSHIPS IN PRAIRIE NATURAL AREAS¹

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Shelford (1963:329) depicts a "common morning scene" on the prairie before the coming of the white man as "a herd of bison or pronghorns in the distance, jack rabbits returning to their forms, a wolf or coyote trotting to its den, several small birds flying overhead and singing, and locally a prairie dog or a ground squirrel sitting upright at its burrow."

Today, when one looks out over the prairie lands of this country, he sees a different scene. We have traveled well over a century through time since the temperate grasslands of North America carried vast herds of bison and pronghorn. The burrowing animals such as the prairie dog have been effectively removed. Predators such as the wolf and primitive man are gone, and the black-footed ferret is on the endangered list. The coyote has remained and thrived despite man's efforts to eliminate him. The prairie chicken remains only in remnant populations.

The creation of a national or state area designed to approximate native prairie conditions brings up some interesting management problems. We cannot just select an appropriate

vegetative area and then leave it alone. At least certain animal species that we know once roamed the pristine grasslands must be reintroduced. Since a selected area has some size limitation, it must be enclosed with a fence or have some natural barrier to prevent depredation on nearby private ranges by large herbivores. This simple act of fencing off an area makes a sound management plan necessary.

In this paper, we will comment on large herbivores and predators as they relate to native prairies. Much of the information presented here is based on our bison-behavior research at Wind Cave National Park in South Dakota. We shall also attempt to point out some of the management problems that might be anticipated and suggest some possible solutions.

THE HERBIVORES

There can be little doubt that the two major prairie dominants among large herbivores was the bison and the pronghorn. Estimates vary, but at least 60 million bison once roamed over North America, with at least 45 million occurring in all parts of the grasslands except California (Shelford 1963). Pronghorn populations have been estimated at between 20 and 100 million (Seton 1929). Although some authors indicate that pronghorns tended to occupy drier portions of the grasslands than did the bison, these two species shared much of the same range.

Bison feed primarily on grass. In terms of animal units, they are considered nearly equal to domestic cattle. That is, stocking

¹Journal Paper No. J-7489 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1664. Administered by Iowa Cooperative Wildlife Research Unit, which is supported by the Bureau of Sport Fisheries and Wildlife (U.S. Dept. Interior), Iowa State University of Science and Technology, Iowa State Conservation Commission, and the Wildlife Management Institute.