preliminary environmental assessment

appendixes A thru N

october 1975

D-9
Vol. 2 of 2
File:
Tallgrass
Prairie
National
Preserve

PROPOSED

PRAIRIE

NATIONAL PARK / KANSAS-OKLAHOMA

Color Scans
12/10/2002

PLEASE RETURN TO:

TECHNICAL INFORMATION CENTER
DENVER SERVICE CENTER
NATIONAL PARK SERVICE

A: PLANNING DIRECTIVE – PROPOSED PRAIRIE NATIONAL PARK

See D-846

B: STUDIES LEADING TO THE PROPOSED PRAIRIE NATIONAL PARK ENVIRONMENTAL ASSESSMENT

STUDIES LEADING TO THE PROPOSED PRAIRIE NATIONAL PARK ENVIRONMENTAL ASSESSMENT

Although the possibility of establishing a tallgrass-prairie preserve has been under consideration since the early 1930s, only the more recent history of prairie studies is included here. (For a brief discussion of early prairie-related efforts, see the Proposed Prairie National Park planning directive, appendix A.) Most of these studies were directed by the National Park Service, and were prompted by a 1956 resolution of the Secretary of the Interior's advisory board which recommended that grassland studies be pursued in order to identify "superlative areas" for inclusion as "national monuments in the National Park Service."

TALLGRASS PRAIRIE REGIONAL STUDY

Between 1956 and 1966 one of the goals of the National Park Service's Mission 66 conservation program was to round out the National Park System by adding to it those resources that were lacking or inadequately represented. One of the most obvious voids was a grassland park. Priority was placed on the inclusion of a tallgrass-prairie site representative of the Central Lowlands and grassland landscapes, because most other grassland types were not as extensive and were at least partially represented in the Park System (note table 1).

In 1958 and 1959 a survey of the tallgrass-prairie region was conducted to identify areas suitable for inclusion in the National Park System. This survey considered potential park sites from the Canadian border to Texas, using four criteria for screening and evaluating these sites: adequate size, prairie typicalness, scenic variety and appeal, and relative lack of intrusions. To meet the size requirement, study areas had to cover at least 30,000 acres (at the time, a 30,000-acre site was considered large enough to minimize adverse effects on native plants and animals and to provide for the grazing needs of big game). To be considered "typical prairie," sites had to contain representative topography and drainage systems and had to support representative vegetation and wildlife. To meet the criterion of scenic variety and appeal – considered paramount in determining site suitability – areas had to include diverse and interesting landforms, free-flowing streams, and wooded growth in drainages. The extent and nature of physical intrusions were recorded and evaluated.

Employing these criteria, scientists identified 24 grassland sites that warranted consideration based on size. However, of these, only 16 were considered typical of prairie, and only 6 exhibited sufficient scenic variety and appeal and lacked extensive intrusions. Moreover, most of the areas eliminated were located at the northern, southern, and western extremities of tallgrass prairie, where atypicalness could be expected and where cyclic weather changes could bring about dramatic changes in ecological conditions.

Table 1 — Representation of Grassland Types in the National Park System (areas over 10,000 acres)

Shortgrass and Mixed Prairies
- Theodore Roosevelt National Memorial Park
- Badlands National Monument
- Wind Cave National Park
- Lake Meredith Recreation Area
- Grand Canyon National Park

Coastal Prairie
- Padre Island National Seashore*

Desert Plains Grassland
- Big Bend National Park
- Guadalupe Mountains National Park
- Carlsbad Caverns National Park
- White Sands National Monument
- Petrified Forest National Park

Palouse Prairie
- Glacier National Park*
- Bighorn Canyon National Recreation Area

California Grassland
- Pinnacles National Monument*

Tallgrass Prairie
- Platt National Park-Arbuckle Recreation Area*

*Marginal representativeness

The six areas meeting all four criteria were Gregory County, South Dakota; Manhattan, Kansas; Chase County, Kansas; Elk County, Kansas; Osage County, Kansas and Oklahoma; and Comanche County, Oklahoma. Through contractual arrangement with Fort Hays State College, Drs. G.B. Tomanek and F.W. Albertson again studied these six areas for prairie typicalness.* As a result, the Gregory and Comanche County areas were eliminated from further consideration because they were atypical tallgrass-prairie sites, because they lacked the diverse range sites common to a tallgrass-prairie ecosystem, or because they had less grass-growth potential than the other areas.

Interestingly, the four remaining areas (Manhattan, Chase, Elk, and Osage) that were considered nationally significant and suitable for inclusion in the National Park System were all located in the Flint Hills of Kansas and Oklahoma. This was undoubtedly no accident, as the Flint Hills possess by far the largest extant tallgrass-prairie region lying in a median and favorable location from the standpoint of geography and climate.

FIRST PRAIRIE NATIONAL PARK PROPOSAL – POTTAWATOMIE COUNTY

In 1960 the National Park Service prepared a report (*Reevaluation Study – True Prairie Grasslands*) stating that of the four remaining significant grassland areas, Osage had been determined to be the most suitable and Manhattan the most feasible for designation as a Prairie National Park. Following publication of this report, the Manhattan area was recommended as the site for a Prairie National Park, and in 1961 the National Park Service issued a planning report entitled *A Proposed Prairie National Park,* which suggested that a 57,000-acre preserve be set aside in Pottawatomie County, Kansas. The plan proposed a rather extensive, one-way internal road system circulating through the restored prairie landscape, with associated campgrounds, picnic areas, and hiking and riding trails leading to numerous primitive camps, viewpoints, and interesting features. Although no major visitor services were recommended within the park, a headquarters area was proposed, with a major park interpretive center.

Due to the lack of widespread public support, as well as conflicts with a major state highway proposal for the area, this proposal was shelved by the Congress.

---

*It should be noted that Tomanek also investigated an area astraddle the Riley-Wabaunsee County line in Kansas. How this area came to be considered cannot be determined from the literature. Tomanek found this small area only poorly comparable to the others, and early eliminated it from further consideration. The area has subsequently been encumbered with highway and oil exploration intrusions. As will be noted later, however, another Wabaunsee County area has since been suggested, and is presently a very real contender.

GREAT PLAINS/PRAIRIE TOURWAY PROPOSAL

During the mid-60s a great amount of attention was directed toward a Great Plains/prairie tourway. The tourway, modeled after the already successful Great River Road, was proposed to follow a series of existing, connected highways from North Dakota into Oklahoma, and to link together (along a protected right-of-way) a number of scenic routes, places of cultural interest, and recreational sites. The tourway was not at that time viewed as a substitute for the proposed Prairie National Park because the two concepts were entirely different in purpose. However, in recent years a prairie parkway has been espoused by some as an alternative to a Prairie National Park.

The tourway studies, directed by the National Park Service and agencies from five prairie/plains states, bore few tangible results, but they did confirm the supposition that the best remaining major relics of tallgrass prairie lie in the Flint Hills of Kansas and Oklahoma.

In the late 1960s, Governor Anderson of Kansas issued a report entitled *Proposed Prairie Parkway,* which urged the Department of the Interior and National Park Service to undertake studies of a possible "Great Prairie Parkway" through Kansas. As proposed, this road was not a true parkway or a ribbon-park. Its design was based on the earlier National Park Service tourway concept, and the parkway was planned to utilize existing roads to connect points of scenic, recreational, and cultural interest in the Kansas Flint Hills. The Kansas Highway Department has since marked this route, but little else has been done to protect the scenic quality of the corridor.

ANTELOPE HILLS STUDY

In 1968, following requests from Senator Burdick and others, the Antelope Hills area of Pierce County in north-central North Dakota was evaluated as a possible Prairie National Park. Although the area was reasonably intact and quite scenic, it lacked the range-site diversity common to tallgrass prairie. Moreover, it was located near the northern edge of the tallgrass-prairie region and beyond its western edge, indicating potential instability and susceptibility to radical changes under prolonged climatic cycles. The area's vegetation was atypical of tallgrass prairie and more typical of transition or mixed grasslands. Further, although the area contained a number of blocks of little-altered native prairie, they were so fragmented that a long process of restoration would have been necessary to re-create the vast primitive landscape.

Nothing concrete came of this proposal.

CHEROKEE STRIP STUDY

The Cherokee Strip study, prepared in 1971, is related to the Prairie National Park proposal both in origin and content. The study came about because of widespread popular support for an investigation of ways and means of preserving historic and natural values associated with the last great homesteading rush on prairie land in the U.S. This study concluded that "a National Historical Park to commemorate the opening of the Cherokee Strip, if combined with significant area of prairie to preserve the natural setting against which the historical drama was enacted, is both feasible and desirable." It further recommended that the Flint Hills be investigated for a prairie park not to exceed 60,000 acres, in which public fee ownership would not exceed 20,000 acres.* That this proposal stressed the relationship between man and the prairie — the social role of the prairie — points out the interest of area residents in their history.

In addition to the prairie unit, the study proposed National Park Service acquisition of four smaller units: Chilocco Indian School, to tell the Indian story and to commemorate the famous Cherokee Run; a 1,200-acre tract near Caldwell, Kansas, to interpret the Chisholm Trail and the cattle drives from Texas to the Kansas railheads; a pioneer homestead at Cleo Springs, Oklahoma; and a headquarters/interpretive center in Arkansas City. The plan also envisioned cooperative agreements with other public agencies to facilitate preservation and interpretation of related historic properties.

In effect, the present Prairie National Park study is an extension of the Cherokee Strip study, but with a different emphasis. While the Cherokee Strip proposal emphasized human events in a natural environment, the Prairie study stresses the natural environment as a theater for human events. There has been no further action on the Cherokee Strip proposal.

THE NATIONAL PARK SYSTEM PLAN

In 1972 the National Park Service published the *National Park System Plan.* The purpose of this document was to identify major history and natural-history themes — corresponding to significant aspects of our country's cultural and natural heritage — and to indicate which themes were adequately represented, poorly represented, or lacking representation in the National Park System.

The plan is divided into two volumes: History (Part One) and Natural History (Part Two). Because a Prairie National Park would more significantly affect Park Service

---

*This is one of several land-management concepts that will be explored in the environmental assessment.

representation of natural-history themes (although several history themes could potentially be illustrated), Part Two of the plan is discussed first.

Generally employing Fenneman's (1928) classic physiographic divisions, *Part Two of the National Park System Plan: Natural History* divides the nation's natural landscapes into regions, and develops themes indicating the most significant features and aspects of natural history that are represented in these regions, or their subdivisions. The plan comments that the Central Lowlands natural region, of which the tallgrass prairie is considered part, is not presently well represented – and must be if the National Park System is to encompass the best examples of our nation's natural environments.

Natural History

As recently as 200 years ago the tallgrass prairie constituted 400,000 square miles of North America and a considerable portion of the vast Central Lowlands natural region. The *National Park System Plan* points out that the Central Lowlands region is poorly represented (16 percent) in the National Park System. The prime-significance themes of the tallgrass-prairie portion of this region fare little better: plains, plateaus, and mesas – 25 percent; grassland – 30 percent. However, even these statistics are misleading in that these themes are not confined to the Central Lowlands, most National Park System representation is west of the tallgrass ecosystem in the shortgrass and midgrass biomes. The National Park System includes the following areas that are located in former tallgrass prairie: Pipestone National Monument, Herbert Hoover National Historic Site, Lincoln Home National Historic Site, Homestead National Monument, Platt National Park, Arbuckle Recreation Area, and Lyndon B. Johnson National Historic Site. However, none of these sites was established primarily to preserve a tallgrass-prairie ecosystem. All are relatively small, five are primarily historic in emphasis, and several are heavily urbanized.

Part Two of the National Park System Plan: Natural History says that "very few patches of Tall Grass Prairie remain today because the productive land is being utilized for agriculture. This vegetation type will disappear if measures are not taken soon to preserve a segment of it. . . . The National Park System includes no unit with significant amounts of . . . Tall Grass Prairie. . . ."

Other natural-history themes of prime significance in the Central Lowlands are not well illustrated in the tallgrass prairie, and even less so in the largely unglaciated Flint Hills – the only expansive area of tallgrass prairie remaining in the U.S. Eolian landforms, river systems/lakes, works of glaciers, and seashores/lakeshores/islands are all landform themes better illustrated in the glaciated terrain north of the Flint Hills (although the Wabaunsee area does contain some glacial outwash and is visually different from the other two areas). Similarly, the lakes-and-ponds aquatic-ecosystem theme is not well illustrated in the Flint Hills.

Representation of significant, but not prime, themes can likewise be augmented by a Prairie National Park — cambrian/early silurian, lake silurian/devonian, eastern deciduous forests, and stream ecosystems. The cuestas/hogback theme, while significant in the Central Lowlands, is not well illustrated in the Flint Hills.

History

A Prairie National Park would aid in relating a number of historical themes now poorly represented in the National Park System. For example, of the 32 major facets of the original-inhabitants theme, seven are represented in the Park System, but only one (aboriginal technology — quarrying) concerns aboriginal cultures of the tallgrass prairie.

Only 15 of the 41 major facets of the other major historic theme of the tallgrass prairie — westward expansion, 1763-1898 — are represented. And of the 10 major facets most pertinent to the tallgrass prairie, four are not represented at all (California Trail, Santa Fe Trail, advance of the farmers' frontier to the 95th Meridian, and the cow towns); four are only marginally represented (military-Indian conflicts on the southern plains, military-Indian conflicts on the northern plains, ranches of the cattleman's empire, and great trail drives), while the other two seem adequately represented (Oregon Trail and settlement of Oregon, and settling and farming the Great Plains).

A Prairie National Park also relates very strongly to the agriculture subtheme of the theme "America at Work," which has no representation in the National Park System.

C: PHYSIOGRAPHIC RESOURCES

PHYSIOGRAPHIC RESOURCES
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by

Department of Landscape Architecture
Kansas State University
and
Denver Service Center
National Park Service

CONTENTS

MAPS

* These maps, prepared at a 1:24,000 scale, are not reproducible without unacceptable loss of information. All these maps can be reviewed at the National Park Service's Denver Service Center. Some can be reproduced at full scale on request and at the expense of the requestor.

INTRODUCTION

The Flint Hills are underlain by layers of sedimentary rock of Pennsylvanian and Permian age. These strata were deposited in an ancient inland sea that once covered part of the mid-continent region. As the sea expanded, the characteristic limestones were deposited in its bottom. Large quantities of flint and chert nodules formed within the limestone, as percolating waters dropped silica around bits of shell, plant-stems, and other impurities.

Later, the region was uplifted and the seas drained, but it was again submerged beneath the vast continent-wide seas of the Cretaceous period. These seas, too, finally drained away as the mid-continent was elevated in more recent geological time. Erosion has gradually removed all the overlying sediments and is today picking away at the outcrops. The resistant limestones survive longer than the softer shales and sandstones, thus forming the numerous ridges of the grasslands.

The flint and chert nodules are hard and insoluble, and have been left behind as residue even though the rock that once contained them has washed away. At certain places in the region, the flint fragments have accumulated to form a mantle of flint-gravel, which helps protect underlying soil and rock from continued erosion. These underlying rocks dip gently to the west, and slope away from the Ozark Dome to the east and southeast. Evidently as the Ozarks domed upward — very slowly and long ago — these originally flat-lying strata were gently tilted. Although scarcely perceptible to the eye, this slight tilt has been sufficient to give most east-facing ridges a steep face, and west-facing exposures a long, gentle slope. This general picture is greatly modified locally by erosion of gullies, and regionally by through-flowing major streams.

Thus the physiographic features of the Flint Hills today are much as they were in late Tertiary times 25 million years ago (Weaver 1971). Alternate layers of limestone, softer shale, and sandstone have eroded to form a landscape with flat-topped hills and terraced slopes dipping slightly to the west. Drainages emerge from springs of water-bearing strata outcropping along hillsides, becoming narrow-to-broad alluvial bands in lowland drainages.

APPLICATION TO RELATED STUDIES

For the purposes of this study, four elements of physiography have been mapped for each study area. These include general relief, slope, aspect, and drainage patterns. Each of these elements has been mapped to provide basic physiographic information for the *range-site survey* (appendix E), *wildlife ecology study* (appendix F) and the natural/scenic resources study (appendix I).

These physiographic maps were planned to facilitate the delineation of range sites and wildlife habitats. Slope categories were established on the basis of the natural topographic position that range sites occupy in the Flint Hills. Slope categories include 0-3 percent, 3-10 percent, 10-25 percent, and over 25 percent. General relief (mapped in 100-foot elevation changes), aspect (mapped as north-, south-, east- and west-facing slopes), and drainage patterns were also used to establish range sites and wildlife habitats.

These same physiographic maps were utilized in developing the natural/scenic resource maps. In the process of establishing visual units, and "viewsheds" of existing land uses, all of the physiographic information was utilized.

The physiographic maps will be very important in the preparation of the archaeological resources report, because there is a direct relationship between archaeological sites and physiographic resources.

DESCRIPTION OF PHYSIOGRAPHIC RESOURCES

Those aspects of physiography that aid in determining the representativeness of the study areas are discussed in this section. The late Dr. J.E. Weaver described the true (tallgrass) prairie as having level areas, knolls, steep bluffs, rolling-to-hilly land, valleys, and extensive alluvial floodplains. These characteristic landforms are readily identifiable on the physiographic maps and are described as they relate to the three areas under study.

WABAUNSEE STUDY AREA

The Wabaunsee area has the greatest elevation extremes of the three study areas. There is more than a 500-foot difference in elevation between the upland ridge along the southern border (1,600 plus feet) and the Mill Creek Valley (under 1,100 feet). The entire area drains to the north, with three prominent north-south trending ridges separating watersheds. These ridges extend from the east-west trending upland ridge that parallels the southern edge of the study area.

The upland ridges are characteristically flat-topped, dipping to the west. Slopes over 25 percent occur on the terraced hillsides of each of the watersheds. Valley bottoms are characteristically flat alluvial floodplains (0-3 percent slopes). The entire area is composed of Permian limestones and shales.

The area encompasses the entire Illinois Creek watershed and the middle branch of the Mill Creek watershed, as well as the headwaters of the east and south branches of Mill Creek. In general, there is a striking regularity to the pattern of ridges and valleys in the Wabaunsee area, and at the same time there is a high degree of physiographic diversity (see the Wabaunsee Relief map, PRAI 40,017, Slope map, PRAI 40,020, and Aspect and Drainage map, PRAI 40,023).

CHASE STUDY AREA

The Chase area lies roughly in the middle of the Flint Hills and encompasses the Flint Hills Ridge, the highest in the region. This ridge trends east to west through the area, with elevations ranging from 1,500 feet to over 1,650 feet. Chase is also underlain by Permian age bedrock.

WABAUNSEE – RELIEF*

NATIONAL PARK SERVICE
DENVER SERVICE CENTER
LIBRARY COPY

WATER RESOURCES
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
Donald R. Albin
(with M.V. Marcher on Osage Study Area)
U.S. Geological Survey
Lawrence, Kansas

CONTENTS

TABLES

ILLUSTRATIONS

* These maps, prepared at a 1:24,000 scale, are not reproducible without unacceptable loss of information. All these maps can be reviewed at the National Park Service's Denver Service Center. Some can be reproduced at full scale on request and at the expense of the requestor.

INTRODUCTION

This report has been prepared in response to a request from the National Park Service for an evaluation of the water resources of three alternative study areas in Kansas and Oklahoma that are being considered for possible designation as a Prairie National Park. General information on water resources is needed to aid in determining which, if any, of the three areas being considered is suitable and feasible for addition to the National Park System. Detailed studies may be made in the future if one of the areas is selected.

Data for this report were compiled entirely from published reports and from the files of various federal and state agencies. No field work was done.

Special thanks are extended to the following persons whose cooperation made the timely completion of this report possible. W.E. Steps of the Kansas Water Resources Board compiled information on water-management districts, resource-conservation and development districts, and soil-conservation districts. G.E. Hilmes of the Division of Water Resources, Kansas State Board of Agriculture, supplied information on water-right applications. G.A. Stoltenberg of the Division of Environment, Kansas Department of Health and Environment, provided information on chemical and bacteriological quality of water in the streams. H.P. Dickey of the U.S. Department of Agriculture, Soil Conservation Service, provided information on reservoirs constructed by the Soil Conservation Service.

GENERAL STREAMFLOW CHARACTERISTICS

Records adequate to determine the flow characteristics of streams in the three areas are not available. However, estimates of certain streamflow characteristics can be made using techniques that "regionalize" records of flow collected at gaging stations on nearby streams. In Kansas, data collected at gaging stations can be transferred to points on nearby streams using the relationship between flow and size of drainage area. The accuracy of estimates so obtained varies according to the particular flow characteristic being estimated and according to the size of the drainage area. Generally, estimates are least accurate for very small streams and most accurate for larger streams. Estimates of mean annual runoff of streams in Kansas generally can be made within about 25 percent of the true value.

In Oklahoma data collected at gaging stations can be transferred to points on nearby streams using the relationship between flow and size of drainage area, mean altitude of the drainage basin, mean annual precipitation and pan evaporation, and channel slope. The accuracy of estimates so obtained varies according to the particular flow characteristic being estimated, and generally is least accurate for very small streams and most accurate for larger streams. The estimates are applicable only to streams that are not significantly affected by regulation. Estimates of mean annual runoff generally can be made within about 25 percent of the true value.

Estimates of the percent of time that streams will have very low or no flow are considered to be within about 10 percent of the true value. Estimates of peak discharge during floods may have errors of about 40 percent for floods with 2-year and 10-year recurrence intervals, and about 50 percent for floods with 100-year recurrence intervals.

The Geological Survey has a policy of giving equivalent metric units in parentheses following English units of measure used in reports. Factors for converting from English to metric units are given below.

English unit	Multiply by	Metric unit
Length		
inches (in)	25.4	millimetres (mm)
feet (ft)	0.3048	metres (m)
miles (mi)	1.609	kilometres (km)
Area		
acres	.4047	square hectometres (hm^2)
square miles (mi^2)	2.59	square kilometres (km^2)
Volume		
cubic feet (ft^3)	.02832	cubic metres (m^3)
gallons (gal)	3.785×10^{-3}	cubic metres (m^3)
acre-feet (acre-ft)	1.233×10^{-3}	cubic hectometres (hm^3)
Flow		
cubic feet per second (ft^3/s)	.02832	cubic metres per second (m^3/s)
cubic feet per second per square mile [$(ft^3/s)/mi^2$]	.0109	cubic metres per second per square kilometre [$(m^3/s)km^2$]
gallons per minute (gal/min)	.06309	litres per second (l/s)

ABSTRACT

Water resources in the Wabaunsee study area are limited, but rank second in terms of the quantity of water available in the three study areas. Mean annual runoff of Illinois Creek and the south branch of Mill Creek is about 8,600 and 8,500 acre-feet (11 and 10 cubic hectometres), respectively. The streams are dry or have no appreciable flow about 40 percent of the time. Wells yielding 10 to 100 gallons per minute (0.6 to 6 litres per second) probably can be obtained at depths less than 200 feet (61 metres) in the southwestern half of the area and in alluvium of the south branch of Mill Creek in the northeastern part of the area. Treatment of both ground and surface water to reduce hardness and remove bacteriological hazards would probably be required if the water is used for public supply.

Water resources in the Chase study area are limited in quantity. Based on probable well yields and flow of streams and springs, storage will be required nearly everywhere that dependable supplies greater than about 50,000 gallons (190 cubic metres) of water are needed per day. Treatment of the water to reduce hardness and to remove bacteriological hazards will be required if it is used for public supply. Mean annual runoff from most of the streams in the area is about 6,000 acre-feet (7 cubic hectometres). The streams are dry about 40 percent of the time. Wells yielding 5 to 10 gallons per minute (0.3 to 0.6 litres per second) probably can be obtained at depths less than 200 feet (61 metres) in most of the area. Wells in alluvium of the south fork of Cottonwood River in the northwestern part of the study area may yield as much as 50 gallons per minute (3 litres per second). Springs occur locally where limestone units crop out along hillsides, but the rate of flow of springs in the Chase area is unknown.

Water resources in the Osage study area are considered the best of the three areas, in terms of the quantity of water available. Mean annual runoff of Sand and Buck Creek is about 7,000 and 12,000 acre-feet (9 and 15 cubic hectometres), respectively, but the streams are dry or have no appreciable flow about 40 percent of the time. Wells yielding 25 to 100 gallons per minute (2 to 6 litres per second) probably can be obtained in most of the area.

Two reservoirs have been constructed by the Soil Conservation Service in the northern part of the area, and numerous stock ponds have been constructed throughout the area. Two water-right applications have been filed in the Kansas part of the area, but neither application was perfected as of November 1974.

Chemical suitability of most water for domestic and public supplies would be greatly improved by treatment to reduce hardness. Treatment to remove bacteriological hazards probably will be required if the water is used for public supplies.

HYDROLOGY – WABAUNSEE STUDY AREA*

WABAUNSEE STUDY AREA

GENERAL DESCRIPTION OF STUDY AREA

The Wabaunsee area is the northernmost of the three areas and comprises about 120 square miles (311 km^2) in Wabaunsee County, Kansas. Most of the area is drained by the west, south, and east branches of Mill Creek and by Illinois Creek, all of which flow northward.

Most of the Wabaunsee area is underlain by rocks of early Permian age that consist of limestone and shale. The limestone units are hard, resist weathering, and form long northerly trending ridges with eastward-facing escarpments. The ridges commonly are mantled by a layer of residual chert left behind as the limestone weathers. This mantle of chert gave rise to the name "Flint Hills," which is a term commonly used to describe the general region. The land surface is rolling to hilly. Altitudes range from about 1,600 feet (488 m) above mean sea level in the southeastern part of the site to about 1,040 feet (317 m) in the valley of the south branch of Mill Creek near the northern part of the area. Local relief from ridgetop to valley floor commonly is about 200 feet (61 m). Normal annual precipitation is about 35 inches (890 mm).

SURFACE-WATER RESOURCES

Streamflow Characteristics

Estimates of flow characteristics have been made for Illinois Creek and for the south branch of Mill Creek above the east branch of Mill Creek. The drainage areas of these streams are nearly identical in size and are wholly contained within the Wabaunsee area (see Hydrology map, Wabaunsee study area, PRAI 40,026).

Table 1. Estimated streamflow characteristics in the Wabaunsee study area.

			Peak Discharge		
Stream	Drainage area (mi^2)	Mean annual runoff (acre-ft)	2-yr recurrence interval (ft^3/s)	10-yr recurrence interval (ft^3/s)	100-yr recurrence interval (ft^3/s)
Illinois Creek	35	8,600	2,000	6,000	14,000
South Branch Mill Creek above East Branch Mill Creek	34	8,500	2,000	6,000	14,000

Illinois Creek drains an area of about 35 square miles (91 km^2). Mean annual runoff at the mouth (confluence with the west branch of Mill Creek) is estimated to be about 8,600 acre-feet (11 hm^3). The above estimate is based on a mean flow of 0.34 $(ft^3/s)/mi^2$, which is equivalent to 0.0060 $(m^3/s)/km^2$, for streams draining basins in the Wabaunsee area (Furness, Burns, and Busby 1964, p. 139).

Illinois Creek is not perennial. The stream probably is dry or flows less than 0.1 ft^3/s (0.003 m^3/s) about 40 percent of the time (Furness 1959, pp. 201, 203). Lowest flows generally occur in late summer and early fall.

Peak discharge during floods at the mouth of Illinois Creek can be expected to be about 2,000 ft^3/s (60 m^3/s) with a 2-year recurrence interval (considering long-term averages), about 6,000 ft^3/s (170 m^3/s) with a 10-year recurrence interval, and about 14,000 ft^3/s (400 m^3/s) with a 100-year recurrence interval. These estimates are based on a 2-year 24-hour rainfall intensity of 3.52 inches (89 mm) in the Wabaunsee area (Jordan and Irza 1974, fig. 1) and the relation of flood peaks to this precipitation parameter and drainage area (Jordan and Irza 1974, figs. 2-4).

The south branch of Mill Creek at the confluence with the east branch of Mill Creek drains an area of about 34 square miles (88 km^2), which is nearly the same drainage area as Illinois Creek. Estimates of flow characteristics of the two streams are therefore nearly identical. However, the south branch of Mill Creek at the confluence with the east branch is estimated to have slightly less mean annual runoff than Illinois Creek – about 8,500 acre-feet (10 km^3). Duration and occurrence of very low or no flow, and magnitude of floods with the various recurrence intervals, are estimated to be the same for the south branch of Mill Creek as for Illinois Creek.

Chemical Quality

No chemical analyses have been made of water samples from streams in the Wabaunsee area. The water is thought to be hard but chemically suitable for domestic use and, with treatment to reduce hardness, for public supply. The water is commonly used for livestock.

Results of analyses of water samples from Mill Creek about 0.5 mile (0.8 km) west and 1.0 mile (1.6 km) south of Maple Hill, which is about 15 miles (24 km) east northeast of Alma, have been provided by the Division of Environment, Kansas Department of Health and Environment. The results (table 2) indicate that the water is hard and, more importantly, that it periodically is subject to pollution. Large increases in the concentrations of fecal coliform and fecal streptococcus bacteria following an increase in streamflow on April 30, 1974, indicate that pollutants are carried to the stream by runoff from the land surface. The ratio of fecal coliform to fecal streptococcus indicates that the pollutant is animal waste rather than human. Runoff of precipitation on farm yards in the stream valley is considered to be the source of pollution rather than sewage effluent from Alma, McFarland, or Paxico.

TABLE 2. Chemical and bacteriological analyses of water samples from Mill Creek near Maple Hill.
[Analyses provided by Division of Environment, Kansas Department of Health and Environment. Results in milligrams per litre except as noted.]

Date	Discharge (ft^3/s) 1/	Temperature (°C)	Dissolved calcium (Ca)	Dissolved magnesium (Mg)	Bicarbonate (HCO_3) 2/	Dissolved chloride (C1)	Dissolved nitrate (NO_3)	Total hardness (as $CaCO_3$)	Turbidity (JTU)	Specific conductance (Micromhos/cm at 25°C)	pH (units)	Biochemical oxygen demand (5-day)	Dissolved oxygen	Fecal coliform (colonies per 100 ml of sample)	Fecal streptococcus (colonies per 100 ml of sample)
11-4-71	41	9	77	16	234	18	5.3	258	45	550	8.0	7.0	8.8	2600	1400
11-5-71	32	10	94	27	276	19	4.9	346	15	650	8.0	3.3	9.4	1100	2900
11-8-71	24	7	104	20	290	20	4.2	342	15	680	8.1	2.3	10.1	170	1100
11-9-71	24	3	103	22	298	24	3.5	350	15	700	8.1	2.3	10.6	310	1300
11-10-71	24	4	107	26	298	25	2.4	374	8	730	8.0	1.3	10.2	—	—
11-11-71	24	4	109	23	303	25	5.3	366	8	750	8.0	2.5	9.8	160	310
11-12-71	24	6	109	25	307	24	2.7	375	8	750	8.0	1.8	9.7	60	100
4-24-74	577	14	96	18	327	9.0	4.7	314	150	570	8.0	3.3	8.3	100	1200
4-25-74	511	14	99	18	349	11	4.5	321	100	630	7.9	8.0	8.5	200	800
4-26-74	461	16	102	19	349	11	5.0	332	100	640	8.0	5.3	8.5	190	700
4-29-74	441	17	102	19	351	11	4.9	332	100	740	7.9	2.8	8.1	250	1500
4-30-74	1220	15	96	18	329	9.0	3.9	314	300	600	7.7	2.8	8.0	27000	41000
5-1-74	555	14	59	11	207	7.0	2.3	192	800	370	7.6	4.5	8.1	29000	59000
5-2-74	470	14	80	15	281	8.0	1.4	261	190	500	8.1	3.0	8.5	3100	4000

1 / Discharge estimated from U.S. Geological Survey gaging-station records for Mill Creek near Paxico, which is about 7 miles (11 km) northeast of Alma.

2 / Computed from total alkalinity.

Susceptibility to Pollution

Grazing of cattle in the Wabaunsee area undoubtedly results in bacteriological pollution of the streams, but this pollution is considered to be significantly less than pollution caused by runoff from farmyards in the stream valleys where animals are confined to small areas. Nevertheless, treatment to remove the bacteriological hazard would probably be required if the water is to be used for domestic or public supplies.

Another potential source of pollution of streams in the Wabaunsee area is drainage of waste from the two oil fields (see Hydrology map, PRAI 40,026). Pollution from this source is not considered to be significant, however, because oil-field operations are limited in the area and only a few wells are active.

Water-Management Programs

The Wabaunsee area is included in the Upper Mill Creek watershed, as designated by the Soil Conservation Service under its 566 Program. An application for project development has been approved, but no reservoir construction was authorized as of April 5, 1974 (U.S. Department of Agriculture, Soil Conservation Service 1974).

There are no local watershed-management or development districts in the Wabaunsee area.

Water Rights

Only one application has been filed with the Division of Water Resources, Kansas State Board of Agriculture, for a water right in the Wabaunsee area. The application, which is not yet (November 1974) a vested right, is on the west branch of Mill Creek in Sec. 2, T.13 S., R.9 E. (pl. 2), for a flow of 0.5 ft^3/s (0.01 m^3/s) to maintain 20 acre-feet (0.02 hm^3) of storage. Water stored under the right will be used for irrigation. Whether or not reservoir construction has begun is unknown.

GROUNDWATER RESOURCES

Principal Aquifers

Limestone and shale of early Permian age that underlie the Wabaunsee area are included in the Council Grove and Chase groups (Mudge and Burton 1959). Groundwater in these rocks occurs in joints, fractures, and solution openings, primarily in the limestone units. These secondary openings have developed in most of the limestone units, and groundwater probably is available to wells less than 200 feet (61 m) deep everywhere within the Wabaunsee area. The principal aquifers are the Foraker, Grenola, and Beattie limestones of the Council Grove group and the Wreford and Barneston limestones of the Chase group (O'Connor 1953).

Groundwater probably is also available from alluvium and terrace deposits of Quaternary age in the principal stream valleys. In the Wabaunsee area, these

unconsolidated deposits probably are less than 50 feet (15 m) thick; they comprise mostly silt and clay with thin layers of sand and gravel in the basal part. These basal sand and gravel deposits locally may be the best aquifer in the Wabaunsee area in terms of the amount of groundwater available to wells.

Rocks ranging in age from middle Ordovician to Devonian occur at depths from about 2,900 to 3,300 feet below land surface in the Wabaunsee area. These rocks consist primarily of dolomite, limestone, and shale; they contain groundwater that could be used to supplement supplies available from wells in near-surface geologic units or from streams. Principal aquifers in these rocks are the Viola limestone and dolomite units in the Hunton group.

Extent of Development

There are no records on file with the U.S. or Kansas Geological Surveys that show any freshwater wells in the Wabaunsee area larger than those used for stock and domestic supplies. Windmills to pump water for cattle are scattered throughout the area, and most of the farm or ranch units presumably have wells for domestic supply. However, the information available indicates that there are no water wells at all in most of the area, especially where there are no roads.

Many springs issue from limestone outcrops along hillsides throughout the Flint Hills region, and they commonly have been developed into water supplies for livestock. No large springs are known to occur in the Wabaunsee area, but many of the stock ponds that have been constructed undoubtedly are spring fed.

Potential Well Yields

Wells with yields adequate for domestic and stock supplies, generally 5 to 10 gal/min (0.3 to 0.6 l/s) can be obtained nearly everywhere in the Wabaunsee area. In the southwestern half of the site, where limestone units of the Chase group are present and have not been drained by discharge to adjacent streams, it may be possible to obtain wells yielding as much as 100 gal/min (6 l/s). Similar well yields may be available from alluvium and terrace deposits in the valley of the south branch of Mill Creek near the northern part of the Wabaunsee area. Potential yield of wells in the Permian rocks and Quaternary deposits is shown on the Hydrology map (PRAI 40,026), which has been modified from Bayne and Ward (1967). The potential yield of wells drilled into rocks of Ordovician and Devonian age is unknown, but about 30 gal/min (2 l/s) was pumped from each of two wells in these rocks in Wabaunsee County for secondary recovery of oil in 1973 (Oros and Saile 1974). Flow of springs in the Wabaunsee area is unknown, but springs throughout the Flint Hills region commonly flow 10 to 100 gal/min (0.6 to 6 l/s).

Chemical Quality

Water samples for chemical analysis have been collected from one shallow domestic and stock well and from two deep oil-field wells in the Wabaunsee area. Results of the

TABLE 3. Chemical analyses of water samples from selected wells in the Wabaunsee study area. [Results in milligrams per litre except as noted.]

Item	Domestic-stock well in NW¼Sec. 3, T.14S., R. 10E., Wabaunsee County	Oil-field well in Sec. 2, T.13S., R.10E., Wabaunsee County	Oil-field well in Sec. 33, T.13S., R.10E., Wabaunsee County
Well depth (feet)	52	2,927	3,206
Geologic unit	Bader Limestone	Viola Limestone	Viola Limestone
Date of collection	May 11, 1970	November 28, 1950	November 29, 1950
Temperature (°C)	13	38	38
Iron (Fe)	12	–	–
Manganese (Mn)	.14	–	–
Dissolved calcium (Ca)	166	511	443
Dissolved magnesium (Mg)	26	130	77
Dissolved sodium (Na)	21	1/ 3190	1/ 3380
Dissolved potassium (K)	12	–	–
Carbonate (CO_3)	0.0	–	–
Bicarbonate (HCO_3)	405	253	1050
Dissolved sulfate (SO_4)	109	987	51
Dissolved chloride (Cl)	78	5330	5570
Dissolved fluoride (F)	.2	–	–
Dissolved nitrate (NO_3)	20	–	–
Hardness as $CaCO_3$			
Total	521	–	–
Noncarbonate	189	–	–
Dissolved solids (residue at 180°C)	670	10400	10600
Specific conductance (micro-siemens/cm @ 25°C)	1050	–	–
pH (units)	7.3	–	–

1/ Sodium plus potassium as sodium.

analyses are given in table 3. Results from the domestic-stock well are considered to be typical of water from wells in the area that are completed in the limestone units of Permian age, except that the dissolved-iron concentration is unusually high and probably not representative. The water, classified by predominant ions, is a calcium bicarbonate type that is very hard. Treatment to reduce hardness and iron concentration would greatly improve the chemical suitability of this water for domestic use or for public supply.

Results from analyses of water samples from the deep oil-field wells indicate that water from the Viola limestone (middle Ordovician) is very saline and probably is unfit even for stock use. However, water from the Viola in this area is only about one-third as saline as typical sea water and, with desalinization or mixing with good-quality water, represents a potential water supply. Water in the geologic units between the Devonian and Permian rocks in the Wabaunsee area generally is too highly mineralized to be a potential source of water.

Susceptibility to Pollution

Groundwater in rocks of Permian age in the Wabaunsee area is not likely to be polluted except in the vicinity of the two oil fields (shown on the Hydrology map, PRAI 40,026). Cattle grazing in the area is not considered to be a source of significant groundwater pollution. The disposal of brine separated from the oil and the pumping of saline water for secondary recovery of oil are potential sources of pollution. Accidental spills occur and well casings deteriorate in nearly every oil field. If pollution has occurred from oil operations in the Wabaunsee area – and no data are available to so indicate – the polluted water has probably infiltrated the limestone units, percolated to the water table, and moved down the gradient toward the streams that drain the area. Because the oil fields in the Wabaunsee area are small in a real extent, and only four oil wells and one injection well are active (Oros and Saile 1974, pp. 104-105), the susceptibility of groundwater to pollution from oil-field activity in the Wabaunsee area is considered to be small.

Water Rights

No applications for groundwater rights in the Wabaunsee area have been filed with the Division of Water Resources, Kansas State Board of Agriculture.

CHASE STUDY AREA

GENERAL DESCRIPTION OF STUDY AREA

The Chase area is the middle of the three study areas. The area comprises about 150 square miles (390 km^2) in Chase, Butler, and Greenwood Counties, Kansas. Most of the area is drained by the south fork of Cottonwood River, the west branch of Fall River, and the north branch of Verdigris River, and their tributaries.

The Chase area is similar geologically and topographically to the Wabaunsee area. Altitudes are slightly higher, ranging from about 1,650 feet (503 m) above mean sea level along the east-central boundary of the site to about 1,220 feet (372 m) in the valley of the west branch of Fall River near the southern boundary of the site. Local relief from ridgetop to valley floor commonly is about 200 feet (61 m). Normal annual precipitation is about 36 inches (914 mm).

SURFACE-WATER RESOURCES

Streamflow Characteristics

Estimates of flow characteristics are given in table 4 for the principal streams in the Chase area. Drainage areas of these streams are shown on the Hydrology map, Chase study area, PRAI 40,027.

The principal streams in the Chase area drain areas ranging in size from 14 to 25 square miles (36 to 65 km^2). Mean annual runoff ranges from about 3,700 acre-feet (5 hm^3) for Otis Creek at the reservoir in the southern part of the site to about 6,600 acre-feet (8 hm^3) for the north branch of Verdigris River in the northeast part of the area. These estimates (table 1) are based on a mean flow of 0.37 $(ft^3/s)/mi^2$, which is equivalent to 0.0040 $(m^3/s)/km^2$, for streams draining basins in the Chase area (Furness, Burns, and Busby 1964, p. 139).

Table 4. Estimated streamflow characteristics in the Chase study area.

Stream	Drainage area (mi^2)	Mean annual runoff (acre-ft)	Peak Discharge 2-yr recurrence interval (ft^3/s)	10-yr recurrence interval (ft^3/s)	100-yr recurrence interval (ft^3/s)
South Fork Cottonwood River above Thurman Creek	24	6,400	1,800	5,700	13,000
Thurman Creek	23	6,200	1,800	5,700	13,000
Little Cedar Creek	21	5,500	1,700	5,100	11,000
North Branch Verdigris River below unnamed tributary in NE¼ Sec. 34, T.21S., R.9 E.	25	6,600	1,900	5,800	13,000
West Branch Fall River just below Cat Creek	24	6,400	1,800	5,700	13,000
Otis Creek above dam at Otis Creek Reservoir	14	3,700	–	–	–

None of the streams in the Chase area are perennial. All the streams probably are dry or flow less than 0.1 ft^3/s (0.003 m^3/s) about 40 percent of the time (Furness 1959, pp. 201, 203) except, perhaps, for short distances where they issue from springs. Lowest flows generally occur in late summer and early fall.

Peak discharge during floods of the streams can be expected to be about 1,700 ft^3/s (48 m^3/s) with a 2-year recurrence interval (considering long-term averages) on Little Cedar Creek, to about 13,000 ft^3/s (370 m^3/s) with a 100-year recurrence interval on most of the other streams (table 4). These estimates are based on a 2-year 24-hour rainfall intensity of 3.66 inches (93 mm) in the Chase area (Jordan and Irza 1974, fig. 1) and the relation of flood peaks to this precipitation parameter and drainage area (Jordan and Irza 1974, figs. 2-4).

HYDROLOGY – CHASE STUDY AREA*

Chemical Quality

No chemical analyses have been made of water samples from streams in the Chase area. The water is thought to be hard but chemically suitable for domestic use and, with treatment to reduce hardness, for public supply. The water commonly is used for livestock.

Selected results of analyses of water samples from the south fork of Cottonwood River and from Verdigris and Fall Rivers have been provided by the Division of Environment, Kansas Department of Health and Environment, and are listed in table 5.

The results indicate that the water is hard and that it can be classified by predominant ions as a calcium bicarbonate water, which is typical of streams draining limestone terrains. Monthly samples collected from Fall River during 1964-70, on file with the U.S. Geological Survey, indicate that the results given in table 5 are typical.

Susceptibility to Pollution

Grazing of cattle in the Chase area undoubtedly results in bacteriological pollution of the streams, but the degree of pollution is considered to be insignificant unless the water is to be used for domestic or public supplies. For these uses, treatment to remove the bacteriological hazards probably would be required.

A potential source of pollution of streams in the Chase area is drainage of waste from the Scott and Teeter oil fields in the east-central part of the area (see Hydrology map, PRAI 40,027). There were 31 oil wells and 9 brine-injection wells active in the two fields in 1973 (Oros and Saile 1974, pp. 50-52), but there are no records that indicate significant pollution of any streams in the area from oil-field waste.

Another potential source of pollution is leakage from the seven oil and gas pipelines that cross the Chase area. Three of the pipelines are for transporting oil, two are for oil products (gasoline and liquified petroleum gas), and two are for natural gas (Oros 1974). Whether or not pollution has occurred by leakage from any of the pipelines is unknown.

Water-Management Programs

The Chase area comprises parts of three watershed projects designated by the Soil Conservation Service under its 566 Program. The part of the Chase area drained by the north branch of Verdigris River and its tributaries is in the Upper Verdigris River watershed. The part of the area drained by the west and east branches of Fall River and their tributaries is in the Upper Fall River watershed. The part of the area drained by the south fork of Cottonwood River and its tributaries is in the South Fork watershed. Construction of reservoirs is complete in the Upper Verdigris River and Upper Fall River watersheds. Information about the reservoirs is given below (H.P. Dickey, written communication 1974).

TABLE 5. Selected chemical and bacteriological analyses of water samples from streams near the Chase study area.

[Analyses provided by Division of Environment, Kansas Department of Health and Environment. Results in milligrams per litre except as noted.]

Stream	Date of collection	Temperature (^{o}C)	Dissolved calcium (Ca)	Dissolved magnesium (Mg)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Dissolved sulfate (SO_4)	Dissolved chloride (C1)	Dissolved nitrate (NO_3)	Dissolved phosphate (PO_4)	Total hardness (as $CaCO_3$)	Turbidity (JTU)	Specific conductance (Microsiemens/cm @ 25^{o}C)	pH (units)	Biochemical oxygen demand (5-day)	Dissolved oxygen	Fecal coliform (colonies per 100 ml)	Fecal streptococcus (colonies per 100 ml)
South Fork Cottonwood River	10-14-72	18	91	19	325	0.0	51	25	0.4	0.18	308	6	580	8.0	1.8	6.3	25	270
Verdigris River	10-14-72	19	83	19	283	0.0	26	100	.9	.16	288	7	730	8.0	1.3	8.2	10	100
Fall River	10-14-72	18	94	19	300	0.0	31	41	.9	.72	244	15	900	7.9	2.5	5.6	25	1400

Reservoir location	Drainage area above reservoir (mi^2)	Volume of storage Sediment pool (acre-ft)	Flood pool (acre-ft)
Upper Verdigris River			
T.21 S., R.9 E., Sec. 26, 35	25	895	4,335
Upper Fall River			
T.23 S., R.8 E., Sec. 34	4	124	1,039
T.24 S., R.8 E., Sec. 3	3	92	762
T.24 S., R.8 E., Sec. 3	2	68	470
T.24 S., R.8 E., Sec. 16	9	288	2,403
T.24 S., R.8 E., Sec. 28	7	226	1,880
T.24 S., R.9 E., Sec. 30	15	481	4,007

No reservoirs have been constructed in the part of the Chase area that is in the South Fork watershed. However, authorization has been received for planning (U.S. Department of Agriculture, Soil Conservation Service 1974).

The Flint Hills Resource Conservation and Development District includes the part of the Chase area that is in Chase County. At present (1974), there is no known construction or development activity within the Chase area by the Flint Hills District.

Water Rights

Three applications for surface-water rights in the Chase area (see Hydrology map, PRAI 40,027) have been filed with the Division of Water Resources, Kansas State Board of Agriculture. The applications are for water for domestic and livestock uses. The water rights probably will be perfected in 1975 because the reservoirs (Soil Conservation Service) have been constructed.

GROUNDWATER RESOURCES

Principal Aquifers

Limestone and shale of early Permian age that underlie the Chase area are included in the Admire, Council Grove, and Chase groups (O'Connor 1951, Mudge and Yochelson 1962). Groundwater in these rocks occurs in joints, fractures, and solution openings, primarily in the limestone units. These secondary openings have developed in most of the limestone units, and limited amounts of groundwater are available to wells less than 200 feet (61 m) deep in most of the Chase area. The principal aquifers are the Foraker, Grenola, and Beattie limestones of the Council Grove group and the Wreford and Barneston limestones of the Chase group (O'Connor 1951, 1953).

Groundwater is available also from alluvium of Quaternary age in the principal stream valleys. In the Chase area, the alluvium probably is less than 40 feet (12 m) thick; it comprises mostly silt and clay with thin layers of sand and gravel in the basal part. The basal sand and gravel deposits locally may provide the best aquifer in the Chase area in terms of the amount of groundwater available to wells.

Extent of Development

Records on file with the U.S. and Kansas Geological Surveys indicate that few water wells have been drilled in the Chase area. Windmills to pump water for cattle are scattered throughout the area, and most of the farm or ranch units presumably have wells for domestic supply. So far as is known, about five wells are used to supply water for the Matfield Green service facility on the Kansas Turnpike at the western boundary of the area. There are no wells at all in most of the area, especially where there are no roads.

Many springs issue from limestone outcrops along hillsides throughout the Flint Hills region, and they commonly have been developed into water supplies for livestock. No large springs are known to occur in the Chase area, but many of the stock ponds that have been constructed undoubtedly are spring fed.

Potential Well Yields

Yields of wells in most of the Chase area probably will not exceed 5 to 10 gal/min (0.3 to 0.6 l/s). Best yields, in general, will be from wells in the higher-altitude central part of the area near the drainage divides between the north branch of Verdigris River, the south fork of Cottonwood River, and the east and west branches of Fall River. This part of the area is underlain by limestone units of the Chase group, which have the greatest potential of the bedrock units for yielding water to wells.

Wells completed in the alluvium of the south fork of Cottonwood River in the northwest part of the area may yield as much as 50 gal/min (3 l/s). Records on file with the U.S. Geological Survey show that a municipal water-supply well in the alluvium near Matfield Green was test pumped for 6 hours at a rate of 42 gal/min (2.6 l/s).

The rate of flow of springs in the Chase area is unknown, but springs throughout the Flint Hills region commonly flow 10 to 100 gal/min (0.6 to 6 l/s). Jack Spring, which is about 2 miles (3 km) northwest of the Matfield Green service facility, had a measured flow of 95 gal/min (6 l/s) during a dry period in the fall of 1947. A spring in the NE1/4 Sec. 14, T.23 S., R.8 E. probably has significant flow because it was noteworthy enough to have been located on the topographic map (see Hydrology map, PRAI 40,027).

Table 6. Chemical analyses of water samples from selected wells in the Chase study area.

(Results in milligrams per litre except as noted.)

Item	Well in NE¼ SW¼, Sec. 20, T.22 S., R.8 E.	Well in SW¼ SE¼, Sec. 22, T.22 S., R.8 E.
Well depth (feet)	25	45
Geologic unit	Crouse Limestone	Crouse and Bader Limestones
Date of collection	12-20-68	6-24-48
Temperature (°C)	15	14
Iron (Fe)	0.00	0.83
Manganese (Mn)	.00	–
Dissolved calcium (Ca)	128	87
Dissolved magnesium (Mg)	24	1/ 31
Dissolved potassium (K)	1.2	–
Carbonate (CO_3)	0.0	–
Bicarbonate (HCO_3)	417	304
Dissolved sulfate (SO_4)	48	26
Dissolved chloride (Cl)	30	15
Dissolved fluoride (F)	.2	.2
Dissolved nitrate (NO_3)	21	80
Hardness as $CaCO_3$		
Total	418	295
Noncarbonate	342	45
Dissolved solids (residue at 180°C)	495	413
Specific conductance (micro-	820	–
siemens/cm @ 25°C)	7.3	–

1/Sodium plus potassium as sodium.

Chemical Quality

Water samples for chemical analysis have been collected from two domestic wells in the Chase area. Results of the analyses are given in table 6. The water, classified by predominant ions, is a calcium bicarbonate type that is very hard. It is considered to be typical of water from wells in the area except that the concentration of nitrate in water from the well in Section 22 is uncommonly high. Treatment to reduce hardness would greatly improve the chemical suitability of groundwater from wells in the Chase area for domestic use or for public supply.

Susceptibility to Pollution

Groundwater in rocks of Permian age in the Chase area probably is not extensively polluted. The uncommonly high concentration of nitrate in water from the well in Section 22 (table 6) indicates that the water locally is polluted. The pollution probably is caused by surface runoff or seepage into the well, which is a problem common to large-diameter domestic and stock wells that are difficult to seal. Grazing of cattle in the area is not considered to be a source of significant groundwater pollution.

The disposal of brine separated from oil and the pumping of saline water for secondary recovery of oil are potential sources of pollution. Accidental spills occur and well casings deteriorate in nearly every oil field. If pollution has occurred from oil operations in the Chase area – and no data are available to so indicate – the polluted water has probably infiltrated the limestone units, percolated to the water table, and moved down the gradient toward the several streams that drain the oil-field area. Because of the relatively small zone from which oil is pumped in each of the drainage basins, the susceptibility of groundwater to pollution from oil-field activity in the Chase area is considered small.

Leakage from one of the oil, oil-products, or natural-gas pipelines that cross the Chase area is another potential source of pollution. Whether or not pollution from this source has occurred in the area is unknown.

Water Rights

No applications for groundwater rights in the Chase area have been filed with the Division of Water Resources, Kansas State Board of Agriculture.

OSAGE STUDY AREA

GENERAL DESCRIPTION OF THE STUDY AREA

The Osage area is the southernmost of the three areas. The study area comprises about 150 square miles (388 km^2) in Chautauqua and Cowley Counties, Kansas, and in Osage County, Oklahoma. About 30 square miles (78 km^2) are in Kansas and about 120 square miles (311 km^2) are in Oklahoma. The area is drained primarily by Rock Creek in Kansas and by Buck and Sand Creeks in Oklahoma. Rock and Buck Creeks flow generally eastward. Sand Creek flows southeastward.

Most of the Osage area is underlain by rocks of late Pennsylvanian and early Permian age that consist primarily of shale, limestone, and sandstone. Many of the limestone and sandstone units are hard, resistant to weathering, and form long sinuous ridges. The land surface is rolling to hilly. Altitudes range from about 1,360 feet (415 m) above mean sea level in the northwestern part of the area to about 800 feet (244 m) in the valley of Caney River in the northeastern portion. Local relief from ridgetop to valley floor commonly is about 100 feet (30 m). Normal annual precipitation is about 35 inches (890 mm).

SURFACE-WATER RESOURCES

Streamflow Characteristics

Estimates of mean annual flow and of peak discharge during floods are given in table 7 for the principal streams that drain the Osage area (see Hydrology map, Osage study area, PRAI 40,028). The flows range from about 1,800 acre-feet (2.2 hm^3) for South Buck Creek, which drains an area of about 9 square miles (23 hm^2), to about 12,000 acre-feet (15 hm^3) for Buck Creek just below Smith Creek. Buck Creek at this point drains an area of about 52 square miles (135 km^2). The estimated flows are based on equations developed by Bohn and Hoffman (1970).

None of the streams in the Osage area are perennial. All the streams in the interior of the area probably are dry or flow less than 0.1 ft^3/s (0.003 m^3/s) about 40 percent of the time (Furness 1959, Sauer, written communication 1974). Records for Caney River at the state line about 3 miles (5 km) east of the study-area boundary indicate that even this stream, which is the major stream in the area, flows less than 0.1 ft^3/s (0.003 m^3/s) about 15 percent of the time. Lowest flows generally occur in late summer and early fall.

Peak discharge during floods of streams in the Osage area (table 7) ranges from about 1,100 ft^3/s (31 m^3/s) with a 2-year recurrence interval (considering long-term averages) at the mouth of Dog Creek to about 23,000 ft^3/s (650 m^3/s) with a 100-year recurrence interval on Buck Creek just below Smith Creek. These estimates are based on equations developed by Sauer (1974).

Table 7. Estimated streamflow characteristics in the Osage study area.

Stream	Drainage area (mi^2)	Mean annual flow (acre-feet)	Peak Discharge: 2-yr recurrence interval (ft^3/s)	Peak Discharge: 10-yr recurrence interval (ft^3/s)	Peak Discharge: 100-yr recurrence interval (ft^3/s)
Buck Creek above South Buck Creek	15	3,000	1,500	4,600	11,000
South Buck Creek	9	1,800	1,200	3,600	8,700
Dog Creek	10	1,900	1,100	3,600	8,600
Smith Creek	10	2,000	1,200	3,700	9,000
Buck Creek just below Smith Creek	52	12,000	3,000	9,300	23,000
Sand Creek above Wild Hog Creek	32	6,900	2,200	6,500	16,000

Chemical Quality

No water samples have been collected for chemical analysis from streams within the Osage area. However, samples have been collected and analyzed from stations near the site on Caney River and on Buck, Pond, and Sand Creeks (Hydrology map, PRAI 40,028). Results of selected analyses are listed in table 8; they were selected on the basis of the minimum and maximum values of specific conductance during the period of record and on a value of specific conductance considered to be typical of values determined during the period of record. Additional results of analyses are available from the U.S. Geological Survey, 1950 Avenue A (Campus West), Lawrence, Kansas 66045.

Interpretation of the data in table 8 and on file with the U.S. Geological Survey indicates that water from streams draining the Osage area is hard, but chemically

HYDROLOGY – OSAGE STUDY AREA*

suitable for the common uses. Treatment of the water to reduce hardness would be desirable if it is to be used for domestic or public supplies.

Susceptibility to Pollution

Result of analyses of water from Caney River, which were provided by the Division of Environment, Kansas Department of Health and Environment, indicate that the stream occasionally is subject to bacteriological pollution. The relatively large concentrations of fecal coliform and fecal streptococcus bacteria in the sample collected near Elgin on July 18, 1972, occurred at a time when streamflow was increasing. The ratio of fecal coliform to fecal streptococcus bacteria indicates that the pollutant is animal waste rather than human. Therefore, runoff of precipitation on farmyards in the stream valley is considered the source of the pollution.

The ratio of fecal coliform to fecal streptococcus bacteria in several water samples collected from Caney River near Elgin in 1968 (not shown in table 8) indicate that sewage effluent was being discharged into the stream. Discharge of sewage apparently has stopped, however, because none of the samples collected since 1968 have contained the bacteria ratio that would indicate pollution of the stream by human waste.

Grazing of cattle in the Osage area undoubtedly results in bacteriological pollution of streams in the interior of the area, but the degree of pollution is considered to be insignificant unless the water is to be used for domestic or public supplies. For these uses, treatment to remove the bacteriological hazard probably would be required.

A potential source of pollution of streams in the Osage area is drainage of waste from oil-field operations. However, there are few oil wells within the Osage area and pollution from this source is not considered significant.

Water-Management Programs

The northern part of the Osage area that is drained by Rock Creek and Caney River is included in the Lower Big Caney watershed as designated by the Soil Conservation Service under its 566 Program (U.S. Department of Agriculture, Soil Conservation Service 1974). Two reservoirs for sediment storage and floodwater detention have been constructed within the Osage area as part of this program (H.P. Dickey, oral communication 1974). The smaller of the two is on Acker Creek in the NW1/4 Sec. 16, T.29 N., R.7 E., Osage County, Oklahoma. Drainage area above the structure is 3.3 square miles (8.5 km^2). Storage in the reservoir totals 744 acre-feet (0.9 hm^3), of which 137 acre-feet (0.2 hm^3) is for sediment storage and the remainder is for flood control. Surface area of the reservoir at flood-pool stage is 46 acres (18.6 hm^2).

The larger of the two reservoirs is on an unnamed tributary of Rock Creek in the SE1/4 Sec. 2, T.35 S., R.8 E., Chautauqua County, Kansas. Drainage area above this

TABLE 8. Chemical and bacteriological analyses of selected water samples from stream-sampling stations near the Osage study area.

[Results in milligrams per litre except as noted.]

Sampling Station and period of record[1]	Date of collection	Discharge (ft^3/s)	Temperature (°C)	Dissolved silica (SiO_2)	Dissolved calcium (Ca)	Dissolved magnesium (Mg)	Dissolved sodium (Na)	Dissolved potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Dissolved sulfate (SO_4)	Dissolved chloride (Cl)	Dissolved fluoride (Fl)	Dissolved nitrate (NO_3)	Dissolved phosphate (PO_4)	Dissolved boron (B)	Dissolved solids (residue at 180°C)	Turbidity (JTU)	Dissolved oxygen	Biochemical oxygen demand (5-day)	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Non-carbonate	Specific conductance (Micro-siemens/cm at 25°C)	pH (units)	Fecal coliform (colonies per 100 ml)	Fecal streptococcus (colonies per 100 ml)
Caney River near Cedarvale	10-17-72	–	–	–	85	20	–	–	303	14.4	22	62	–	1.5	0.10	–	–	6	6.6	0.75	296	24	530	8.0	50	140
Partial records available	10-14-72	–	18	–	83	13	–	–	295	.0	22	51	–	1.5	.17	–	–	7	6.7	.25	260	18	570	7.9	5	400
from October 11-17, 1972	10-15-72	–	–	–	93	17	–	–	325	.0	26	49	–	1.5	.21	–	–	7	5.8	2.5	304	38	620	7.5	120	160
Caney River near Elgin	7-18-72	[2]544	25	6.5	42	7.6	9.5	2.6	146	.0	12	16	0.4	1.2	.18	–	180	160	5.0	2.4	136	16	300	7.8	700	1800
Partial records available	4-2-74	[2]168	16	6.3	89	11	18	2.2	298	.0	32	26	.2	1.8	.97	0.09	334	15	9.6	1.8	267	23	560	7.9	5	10
from May 11, 1967, to the present	1-27-70	[2] 22	2	5.8	106	12	27	2.2	332	.0	40	47	.2	1.7	–	.09	412	3	13.4	.7	314	42	740	8.0	5	10
Buck Creek near Boulangerville	4-9-52	–	14	–	74	11	[3]20	–	254	0	39	17	–	1.4	–	–	313	–	–	–	230	22	504	7.9	–	–
Partial records available	5-15-52	–	22	–	78	14	[3]22	–	285	0	37	20	–	1.4	–	–	327	–	–	–	252	18	554	8.0	–	–
from April 9 to July 10, 1952	7-10-52	–	29	–	77	14	[3]26	–	272	0	22	43	–	1.4	–	–	341	–	–	–	250	26	603	7.7	–	–
Pond Creek near Boulangerville	3-15-52	–	10	–	32	3.7	[3] 8.3	–	109	0	17	3.8	–	1.8	–	–	169	–	–	–	95	6	220	7.2	–	–
Partial records available from	2-27-52	–	8	–	56	9.4	[3]18	–	203	0	31	13	–	1.5	–	–	255	–	–	–	178	12	414	7.8	–	–
February 12 to July 10, 1952	5-15-52	–	24	–	73	10	[3]10	–	259	0	24	6.0	–	1.2	–	–	269	–	–	–	223	11	464	8.1	–	–
Sand Creek near Pawhuska	7-10-52	–	28	–	44	7.3	[3]11	–	167	0	13	8.5	–	1.6	–	–	184	–	–	–	140	3	320	7.3	–	–
Partial records available from	4-9-52	–	14	–	68	9.6	[3]18	–	241	0	34	11	–	1.8	–	–	282	–	–	–	209	12	448	7.9	–	–
February 12, 1952 to February 2, 1953	2-12-52	–	9	–	78	12	[3]16	–	274	0	34	13	–	1.4	–	–	300	–	–	–	244	20	512	8.0	–	–
Sand Creek near Okesa	6-2-54	[4] 23	–	–	16	3.9	6.4	–	60	0	–	10	–	–	–	–	–	–	–	–	56	48	149	8.0	–	–
Partial records available from	9-27-61	[4] 26	–	–	57	8.8	26	–	190	0	23	39	–	1.2	–	–	258	–	–	–	178	22	450	8.2	–	–
September 5, 1951 to September 27, 1961	8-22-60	[4] 2.2	–	–	74	14	119	–	146	0	39	242	–	1.8	–	–	647	–	–	–	244	124	1050	8.2	–	–

[1] Results listed are based on minimum, typical, and maximum values of specific conductance for period of record. A complete list of analyses is available from the U.S. Geological Survey office in Lawrence, Kansas.

[2] Mean daily discharge

[3] Sodium and potassium as sodium

[4] Instantaneous discharge

structure is 4.2 square miles (10.9 km^2). Storage in the reservoir totals 959 acre-feet (1.2 hm^3), of which 186 acre-feet (0.2 hm^3) is for sediment storage and the remainder is for flood control. Surface area of the reservoir at flood-pool stage is 106 acres (42.9 hm^2).

The part of the Osage area drained by Sand Creek is in the Sand-Hogshooter Creeks watershed, and the part of the area drained by Bird Creek is in the Upper Bird Creek watershed, as designated by the Soil Conservation Service. Applications under the 566 Program for reservoir construction in the watersheds have been received, but no planning or construction has been done (U.S. Department of Agriculture, Soil Conservation Service 1974b).

The part of the Osage area drained by Buck and Pond Creeks and their tributaries is not included in any watershed program of the Soil Conservation Service.

There are no local watershed-management or development districts in the Osage area. However, numerous stock ponds for cattle have been constructed in the area.

Water Rights

Two applications for water rights in the Osage area have been filed with the Division of Water Resources, Kansas State Board of Agriculture (Hydrology map, PRAI 40,028). Neither of the applications has yet (November 1974) become a vested right. One of the applications is on Rock Creek in Cowley County for the "natural flow" of the stream to maintain 1,000 acre-feet (1.2 hm^3) of storage for domestic use and recreation. The other application is on a small unnamed tributary of Caney River for a flow of 0.78 ft^3/s (0.02 m^3/s) to maintain 100 acre-feet (0.1 hm^3) of storage for irrigation. Whether or not reservoir construction has begun for either of these water-right applications is unknown. No water rights have been filed in the Oklahoma part of the Osage area.

GROUNDWATER RESOURCES

Principal Aquifers

Shale, limestone, and sandstone of late Pennsylvanian and early Permian age underlie the Osage area. In the stratigraphic nomenclature used in Kansas, these rocks comprise, in order from oldest to youngest, the Shawnee, Wabaunsee, Admire, and Council Grove groups. Principal aquifers in the area (Bayne 1958, 1962) are a sandstone unit in the Kanwaka shale (Elgin sandstone member of Vamoosa formation in stratigraphic nomenclature used in Oklahoma), the Tecumseh shale and Deer Creek limestone (Ada formation in Oklahoma), several sandstone, sandy shale, and limestone units of the Wabaunsee group (Vanoss formation in Oklahoma), and the Foraker, Grenola, and Bader limestones of the Council Grove group. Nearly all the geologic units that underlie the Osage area will yield some groundwater to shallow wells in the outcrop areas of the units.

Groundwater probably is also available from alluvium and terrace deposits of Quaternary age in the principal stream valleys. In the Osage area, these unconsolidated deposits probably are less than 30 feet (9 m) thick; they comprise mostly silt and clay with thin layers of sand and gravel in the basal part. These basal sand and gravel deposits locally may be the best aquifer in the Osage area in terms of the amount of groundwater available to wells.

Extent of Development

No freshwater wells larger than those used for stock and domestic supplies are known to be in the Osage area. Windmills to pump water for cattle are scattered throughout the area, and most of the farm or ranch units presumably have wells for domestic supply. However, information available indicates that there are no water wells at all in most of the area, especially where there are no roads.

Potential Well Yields

Wells with yields adequate for domestic and stock supplies, generally 5 to 10 gal/min (0.3 to 0.6 l/s), can be obtained nearly everywhere in the Osage area. Best yields, 25 to 100 gal/min (2 to 6 l/s), probably can be obtained in the eastern part of the site that is underlain by thick sandstone units and in the northwestern part of the area that is underlain by limestone units. Similar well yields probably are available from alluvium and terrace deposits in the valley of Caney River. Poorest yields generally occur in the central to western part of the area that is underlain by shale and thin limestone units.

Groundwater supplies of 50,000 gallons (190 m^3) per day, which would be adequate for park purposes, probably can be obtained from one or two wells almost everywhere in the Osage area. Therefore, the Osage area is considered to be the best of the three study areas in terms of the quantity of water available.

Chemical Quality

Water samples for chemical analyses have been collected from three domestic and stock wells in the Osage area (Hydrology map, PRAI 40,028). Results of the analyses are given in table 9.

Water from the well in the alluvium is considered to be typical of water from shallow wells in the area. It can be classified by predominant ions as a calcium bicarbonate water that is very hard. Treatment to reduce hardness would greatly improve the chemical suitability of water from shallow wells in most of the area for domestic use or for public supply.

The uncommonly high concentration of nitrate in water from the well in the Wabaunsee group indicates that the water is polluted. Results from this analysis, therefore, are not typical, but they are included to illustrate a problem common to large-diameter shallow wells that are difficult to seal against pollution from the land surface.

Table 9. Chemical analyses of water samples from selected wells in the Osage study area.

(Results in milligrams per litre except as noted.)

Item	Well in SW¼ Sec. 33, T.34 S., R.9 E., Chautauqua County, Kansas	Well in SW¼ Sec. 3, T.35 S., R.8 E., Chautauqua County, Kansas	Well in NE¼ Sec. 3, T.28 N., R.8 E., Osage County, Oklahoma
Well depth (feet)	25	20	300
Geologic unit	Alluvium	Wabaunsee Group	Vamoosa Formation
Date of collection	May 1970	May 1970	April 1973
Temperature (^{o}C)	13	13	–
Iron (Fe)	.08	2.0	–
Manganese (Mn)	.00	.14	–
Dissolved calcium (Ca)	112	205	8.7
Dissolved magnesium (Mg)	6.9	67	1.8
Dissolved sodium (Na)	22	53	230
Dissolved potassium (K)	.9	2.8	–
Carbonate (CO_3)	.0	.0	.0
Bicarbonate (HCO_3)	356	337	378
Dissolved sulfate (SO_4)	35	284	40
Dissolved chloride (Cl)	8.0	100	110
Dissolved fluoride (F)	.1	.3	–
Dissolved nitrate (NO_3)	12	219	12
Hardness as $CaCO_3$			
Total	308	787	29
Noncarbonate	16	511	–
Dissolved solids (residue at 180^{o}C)	382	1152	637
Specific conductance (micro-siemens/cm @ 25^{o}C)	630	1760	1010
pH (units)	7.4	7.3	7.8

Water from the well in the Vamoosa formation is soft and can be classified by predominant ions as a sodium bicarbonate water. It is typical of water from wells in a few of the sandstone and sandy shale units in the eastern part of the area.

Although no water samples have been collected from wells in most of the sandstone units in the Osage area, the water probably is a mixed chemical type in which calcium, magnesium, and bicarbonate are the predominant ions. Water from depths greater than about 200 feet (61 m) in the eastern part of the area and from depths greater than about 400 feet (122 m) in the western part likely will be too saline for domestic use (J.J. D'Lugosz, oral communication 1974).

Susceptibility to Pollution

Groundwater in the Osage area is not considered to be susceptible to significant pollution from any of the present (1974) cattle, farming, or oil-field activities. Pollution occurs locally where stock and domestic wells are not properly sealed against runoff from farmyards. Improper disposal of oil-field brine and accidental spills of oil or wastes are potential sources of pollution, but there are few oil wells in the area compared to the relatively large number in adjacent areas. Most of the oil wells are down-gradient topographically and hydraulically from the Osage area, so the susceptibility of groundwater to pollution from oil-field activities is considered to be small.

Water Rights

No applications for groundwater rights in the Osage area have been filed with the Division of Water Resources, Kansas State Board of Agriculture, or with the Oklahoma Water Resources Board.

SELECTED REFERENCES

BAYNE, C.K.

1958 *Ground-water Resources of Elk County, Kansas.* Kansas Geological Survey, vol. 14, pt. 3.

1962 *Geology and Ground-water Resources of Cowley County, Kansas.* Kansas Geological Survey, bulletin 158.

BAYNE, C.K., and J.R. WARD

1967 *General Availability of Ground Water in Kansas.* Kansas Geological Survey, map M-4.

BOHN, J.D., and G.L. HOFFMAN

1970 *A Proposed Streamflow Data Program for Oklahoma.* U.S. Geological Survey, open-file report.

FURNESS, L.W.

1959 *Kansas Streamflow Characteristics, Flow Duration.* Kansas Water Resources Board, technical report 1.

FURNESS, L.W., C.V. BURNS, and M.W. BUSBY

1964 *Kansas Streamflow Characteristics, Storage Requirements to Control High Flow.* Kansas Water Resources Board, technical report 5.

JORDAN, P.R., and T.J. IRZA

1975 *Kansas Streamflow Characteristics, Magnitude and Frequency of Floods in Kansas.* Kansas Water Resources Board, technical report 11.

MOORE, R.C.

1930 *The Surface Features of Kansas.* Kansas Geological Survey, map 1A.

MUDGE, M.R., and E.L. YOCHELSON

1962 *Stratigraphy and Paleontology of the Uppermost Pennsylvanian and Lowermost Permian Rocks in Kansas.* U.S. Geological Survey, professional paper 323.

O'CONNOR, H.G.

1951 *Ground-water Resources of Chase County, Kansas.* Kansas Geological Survey, vol. 11, pt. 3.

O'CONNOR, H. G.

1953 *Ground-water Resources of Lyon County, Kansas.* Kansas Geological Survey, vol. 12, pt. 3.

OROS, M.O.

1974 *Oil and Gas Pipelines and Industries in Kansas.* Kansas Geological Survey, map M-6.

OROS, M.O., and D.K. SAILE

1974 *Enhanced Oil-Recovery Operations in Kansas, 1973.* Kansas Geological Survey, Energy Resources Series 3.

SAUER, V.B.

1974 *Flood Characteristics of Oklahoma Streams.* U.S. Geological Survey, water resources inventories 52-73.

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

1974a *Watershed Projects in Kansas.* Soil Conservation Service map. Lincoln, Nebraska.

1974b *Watershed Protection and Flood Prevention Progress of Oklahoma.* Soil Conservation Service map (showing status of structures). Fort Worth, Texas.

E: BIOLOGICAL INVENTORIES: RANGE ECOLOGY

BIOLOGICAL INVENTORIES: RANGE ECOLOGY

ALTERNATIVE STUDY AREAS

PROPOSED PRAIRIE NATIONAL PARK

KANSAS/OKLAHOMA

CONTENTS

FIGURES

* These maps, prepared at 1:24,000 scale, are not reproducible without unacceptable loss of information. All these maps can be reviewed at the National Park Service's Denver Service Center. Some can be reproduced full scale on request and at the expense of the requestor.

TABLES

INTRODUCTION

The Flint Hills of Kansas and the Osage Hills of Oklahoma are a part of the true-prairie association which once extended from Canada to Texas through the eastern part of the Dakotas, eastern Nebraska, eastern Kansas, and eastern Oklahoma. To the east, the true prairie is bordered by the oak/hickory deciduous forest association and to the west by the drier mixed-prairie association.

The true prairie was originally found on some of the most productive soils in the world, and consequently much of the original grassland has been plowed and planted to cultivated crops. However, certain segments of the true prairie have persisted as native grasslands because the soils were too shallow, rocky, and steep for cultivation. These grasslands have become some of the most important livestock-grazing regions in the United States. The basic unit on which management of rangeland is determined is the range site. A range site is an area of rangeland that is homogenous in climate, soils, and topography, and produces a specific amount and mixture of vegetation.

The Kansas Flint Hills and the Oklahoma Osage Hills have large acreages of prairie vegetation, and as such constitute one of the few remaining examples of true-prairie vegetation.

CLIMATE

The climate of the Flint Hills is extremely variable. Large and sudden changes in temperature, wind, and precipitation are common. Temperature extremes vary from -32°F to +118°F, with averages being approximately +55°F. The summer winds are usually southerly; in winter, northerly winds prevail.

The mean annual rainfall is about 34 inches in the Wabaunsee study area, 34 inches in the Chase area, and 36 inches in the Osage area. Most of the rainfall occurs during the spring and fall months. Total snowfall averages approximately 18 inches annually, and snow cover rarely remains for long periods. The seasonal aspect of the vegetation is greatly influenced by the seasonality of the rainfall. Climatological records indicate that periodic droughts are characteristic of the climate. Although the effects of such droughts on the Flint Hills/Osage Hills vegetation is not well documented, they have been observed by various ecologists.

GEOLOGY

The Flint Hills represent the western border of the Central Lowlands physiographic province of the United States, and are characterized by prominent scarps and benches

formed on underlying Permian and Pennsylvanian limestones and shales. Physiographically, the Flint Hills consist of a highly dissected plain with relatively smooth divides bordered by rock outcrops and steep slopes. Breaks and escarpments occur near major streams. The elevation ranges from 1,500 feet in the central portion to 850 feet in the southeastern portion.

The northern portion of the Flint Hills in Kansas has a mantle of glacial drift and loess. As a result, this area is extensively cultivated. The western boundary of the Flint Hills appears to be where the Fort Riley limestone outcrops; the eastern boundary coincides generally with the base of the flint-bearing limestone of the Foraker formation. To the south, the Osage Hills of Oklahoma consist primarily of limestone and sandstone hill country. These hills are commonly referred to as scrub oak country and have a savanna landscape.

SOILS

Soils in the Flint Hills have developed residually from massive limestones, interbedded shales, and Permian cherty limestones and in some locations from a thin mantle of loess.

The soils are dark, well-granulated silt loams and silty-clay loams and are often slightly acidic in reaction. The fertility is moderately high and moisture relationships are usually favorable since the broken rock allows moisture to infiltrate readily.

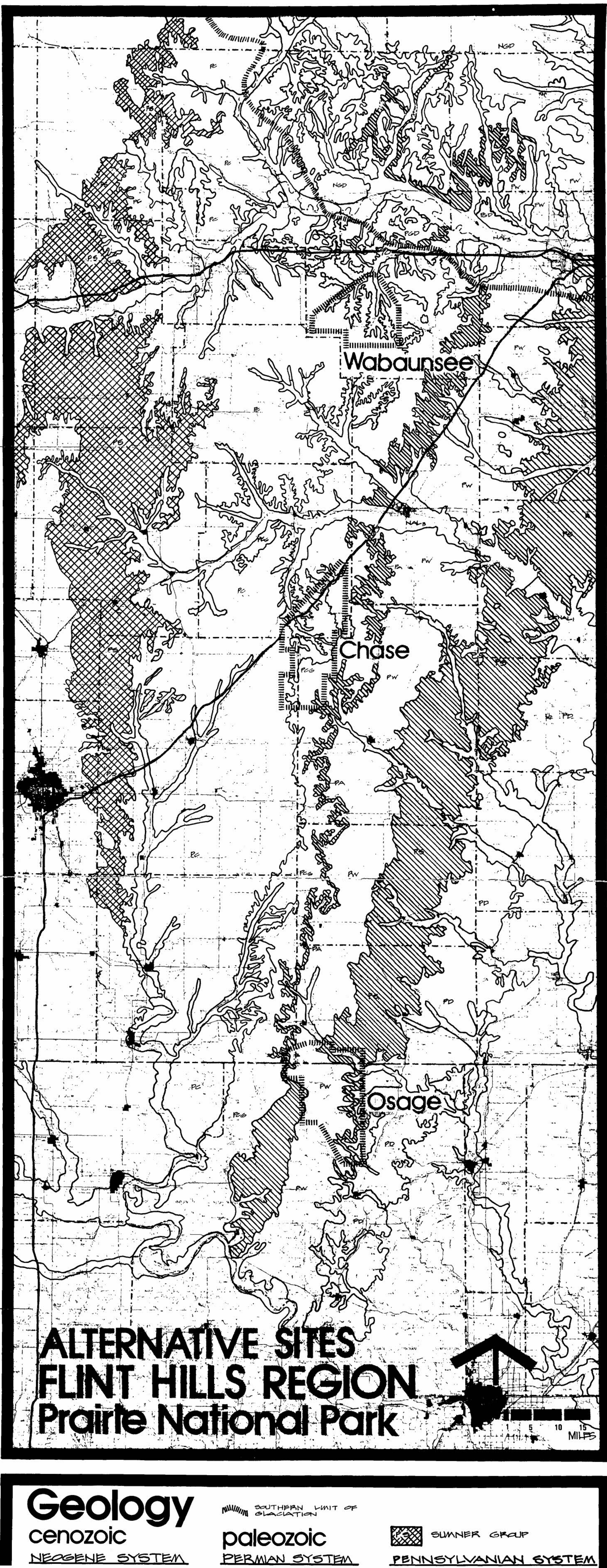
VEGETATION

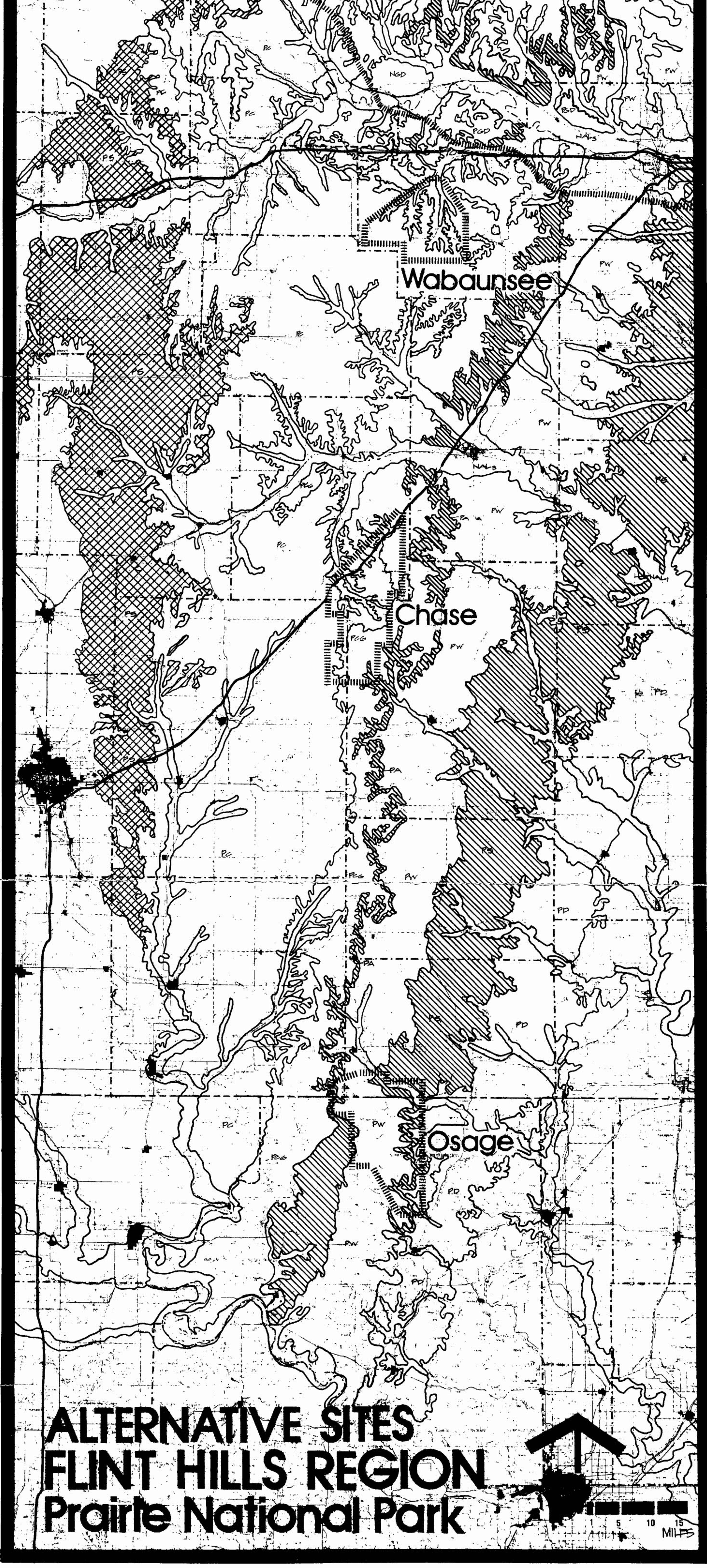
The native vegetation is classified as true prairie and is dominated by mid-length grasses, such as little bluestem *(Andropogon scoparius),* side-oats grama *(Bouteloua curtipendula),* and Kentucky bluegrass *(Poa pratensis),* together with tall grasses, such as big bluestem *(Andropogon gerardi),* Indian grass *(Sorghastrum nutans),* and switchgrass *(Panicum virgatum).* Short grasses, such as blue grama *(Bouteloua gracilis)* and buffalo grass *(Buchloe dactyloides),* occur primarily on dry sites or in overgrazed pastures.

Forbs play a very conspicuous role while flowering, but do not constitute a major percentage by weight of the climax vegetation.

Ravines, creeks, streams, and rivers in the region often support extensive stands of woody vegetation. Trees such as elm *(Ulmus),* oak *(Quercus),* hickory *(Carya),* cottonwood *(Populus),* and ash *(Fraxinus)* are common in the area. Eastern redcedar *(Juniperus virginiana)* has more recently become a conspicuous feature of the woody vegetation, and it poses a management problem to ranchers in many areas.

For a complete cross-referencing of scientific and common names, see enclosure 4.


Wabaunsee
Chase
Osage
ALTERNATIVE SITES
FLINT HILLS REGION
Prairie National Park
5 10 15
MILES
Geology
cenozoic
NEOGENE SYSTEM
SOUTHERN LIMIT OF GLACIATION
paleozoic
PERMIAN SYSTEM
SUMNER GROUP
PENNSYLVANIAN SYSTEM



Geology

cenozoic

NEOGENE SYSTEM

PLEISTOCENE SERIES

NAL 3 — ALLUVIUM

NGD — DRIFT

PLEISTOCENE & PLIOCENE

NAL1 — ALLUVIUM

SOUTHERN LIMIT OF GLACIATION

paleozoic

PERMIAN SYSTEM

PC — CHASE GROUP

PCG — COUNCIL GROVE GROUP

PA — ADMIRE GROUP

PS — SUMNER GROUP

PENNSYLVANIAN SYSTEM

PW — WABAUNSEE GROUP

PS — SHAWNEE GROUP

PD — DOUGLAS GROUP

SOURCE: GEOLOGY MAP OF KANSAS, 1964, 1:500,000
GEOLOGY MAP OF OKLAHOMA, 1954, 1:500,000

391

[redacted] 40032
DSC MAY 75

ON MICRO...

RANGE SITES

RANGE-SITE CONCEPT

Good range management requires detailed information on the structure and function of the range ecosystem. Range managers must know the different types and locations of soils in the rangeland, the types of vegetation communities, and the reaction of various plant species to herbivore grazing. With this information, the range manager can regulate grazing so that vigor and productivity of the vegetation and the soil integrity are maintained over a long period of time.

Range sites have been defined as kinds of rangeland that differ from each other in their ability to produce a significantly different kind or amount of climax or original vegetation. In other words, a range site is a plant community, and it is characterized by different soils, climate, and vegetation.

In most instances, the type of vegetation that occupied a particular site before the site was affected by domestic livestock grazing is referred to as the potential or climax vegetation. Presumably the climax rangeland is in a steady state, and will remain so unless disturbed by fire, grazing, insects, disease, or other factors. Thus, the climax vegetation has been widely used as a base reference for evaluating the condition of rangeland that is being grazed by domestic livestock.

Certain range sites are more abundant and characteristic of the true prairie than others. Four range sites seem to be the most characteristic. In this report, they are referred to as loamy upland, shallow breaks, clay upland, and loamy lowland. These sites are easily identified by the vegetation, soil, and topography. They are considered the predominant range sites of the true prairie and should be present in a "typical" true prairie.

A number of other sites that are common in most true-prairie regions are claypan (dense clay), shallow, very shallow, clay lowland, sandy, upland forest, cross timbers, and riparian forest. The presence of these range sites in a "typical" true-prairie grassland would be very desirable but not as critical.

Certain sites are scattered throughout the true prairie, but are never very large or abundant. They include wetland, subirrigated land, sand, saline upland, saline lowland, badland, savanna, and a number of others peculiar to local areas.

RANGE-CONDITION CONCEPT

Range condition is the present status of the rangeland compared to what it is naturally capable of producing; that is, range condition is the inverse of the degree of departure of a grazed range site from the climax state.

The term range condition has two basic connotations. First, it refers to the amount of forage being produced at a particular time as a result of a particular set of climatic conditions. This concept has no relationship to ecological succession, and has little value in classifying rangelands on the basis of their long-term potential.

The second connotation of the term range condition – as used herein – refers to the actual forage production and species composition which a range site might produce, under sound range management.

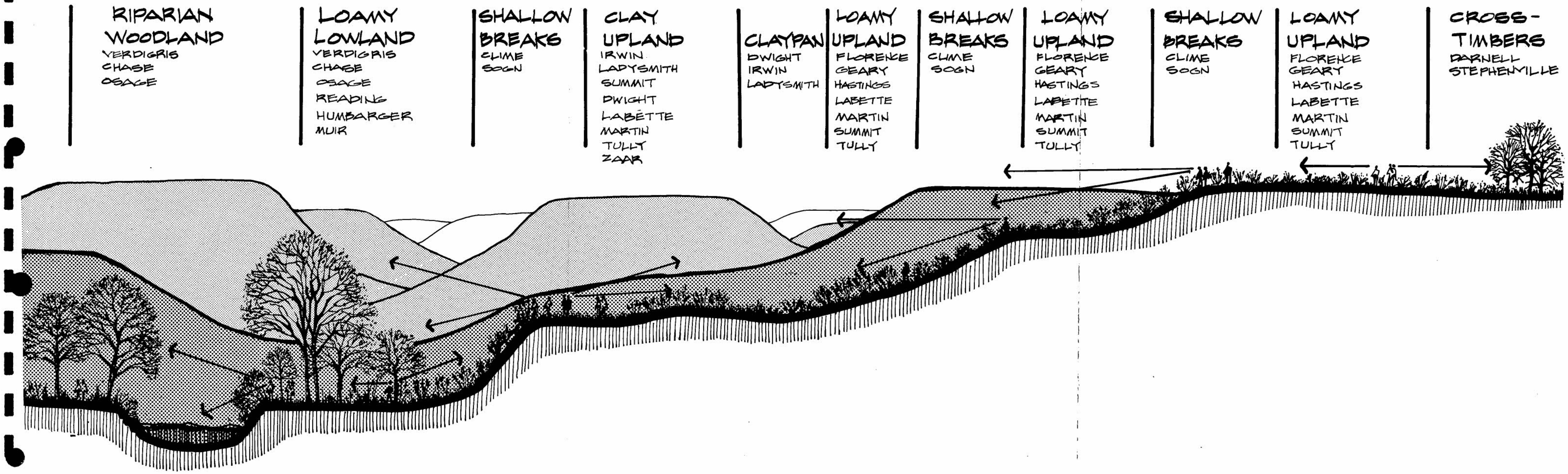
There is often a close relationship between range condition and stages in secondary plant succession. *In general,* the better the range condition, the more advanced the successional stage. However, since the concept of range condition is a utilitarian classification, it is not bound by ecological concepts of succession.

There are many techniques for evaluating range condition, but the method that is used by the Soil Conservation Service of the USDA is for range condition evaluation in the central Great Plains. This method of range condition evaluation has been described in detail by Dyksterhuis (1949).

Range condition for a specific range site is expressed quantitatively as the amount and mixture of current vegetation in relation to that which is normally found on the same site in a climax state. Thus, the closer the current vegetation approaches the climax vegetation, the higher the condition class.

Specific technical range condition guides are available from the Soil Conservation Service for all range sites within a given rainfall regime. Thus, it is possible to quantitatively assess the range condition of a particular site.

Four categories are used by the U.S. Soil Conservation Service to classify range condition: excellent, good, fair, and poor. Excellent indicates that 76 to 100 percent of the climax vegetation is present, good indicates 51 to 75 percent of the climax vegetation is present, fair indicates that 26 to 50 percent of the climax plant species are remaining, and poor indicates that 25 percent or less of the climax vegetation is present.



Typical Prairie Views In The Flint Hills

Range Sites and Related Soil Series

Prairie National Park Study

United States Department of the Interior / National Park Service

Essential information required in range condition evaluation includes the climax vegetation composition, the present vegetation composition, and the response of key indicator species to overgrazing.

Once the range condition has been evaluated, it is possible to utilize the condition class to set stocking rates that will maintain or improve the range condition.

Range condition declines rather dramatically in most rangelands with overgrazing. When this occurs, forage production, plant vigor, and soil stability are reduced. However, proper management can reverse deterioration in range condition, and can bring range sites back to excellent condition. Proper management includes use of correct stocking rates and uniform animal distribution.

Livestock do not graze rangeland plants randomly, but instead select plants preferentially to obtain the most palatable forage. If the degree of grazing is not carefully regulated, the more preferred plants will be overutilized, lose their vigor, and decrease in abundance. Conversely, plants less preferred by livestock will tend to increase in abundance in overgrazed rangelands. Consequently, it is essential that range managers know the response of rangeland plants to grazing pressure.

Range plants are often grouped into three categories, called decreasers, increasers, and invaders, based on their reaction to grazing pressure. Decreasers are plants that will be utilized too heavily if overgrazing is practiced. These are generally nutritious, palatable, and productive grasses and forbs. Increasers are plants that are less palatable to livestock and thus increase at the expense of decreasers with overgrazing. Decreaser, increaser, and invader categorization for plants is shown in tables 8, 9, and 10, if the categories are well known.

Invaders are plants that cannot usually survive the competition from increasers and decreasers when the range site is at or near climax condition. However, with severe overgrazing and the subsequent reduction of decreasers and increasers, invader species rapidly take over the vegetation composition. Most invaders have little or no nutritive value to livestock.

GENERAL RANGE-SITE DESCRIPTIONS

Clay Upland (C)

The clay-upland range site is a nearly level to rolling site occurring on uplands. This range site usually does not occur on slopes exceeding 10 percent, although slopes up to 20 percent are occasionally found.

The soils of this type of site have a loam to silty-clay surface layer that is strongly granular and 7 to 14 inches deep. The subsoil is a fine-textured hard clay and silty clay

that frequently restricts the movement of water into the subsoil. These soils have a high capacity to hold both water and nutrients, but during periods of drought they frequently do not release adequate amounts of water for maximum forage production.

The climax vegetation on this range site is a mixture of tall and mid-length grasses, with approximately 75 percent of the cover composed of decreasers. Primarily, these include big bluestem, little bluestem, Indian grass, and switchgrass. When overgrazed, this range site regresses to stands of short- and midgrass increasers, such as hairy grama *(Bouteloua hirsuta),* blue grama, buffalo grass, and western wheatgrass *(Agropyron smithii).* Forage production varies from year to year, and generally ranges between 1,200 and 8,000 pounds per acre, depending on microsite and microclimate conditions.

Included within the mapped clay-upland range site on the Wabaunsee and Osage study areas are small areas of claypan (P) range site. The claypan site is included in the clay-upland site due to its similar vegetation, topography, and soil characteristics, to the difficulty of accurately delineating the claypan sites, and to their relatively small areal extent. The claypan was mapped for the Chase area where larger acreages were present. The soils of the claypan range site are heavier than the clay-upland soils; thus, the claypan is more droughty than the clay upland.

The Soil Conservation Service in Kansas commonly uses the separate terms clay upland and claypan for this range site (enclosures 1 and 2), whereas, in Oklahoma, other names, such as claypan prairie or shallow claypan, are used (enclosure 3).

Loamy Lowland (L)
The loamy-lowland range site is a nearly level to gently sloping site that receives additional water from occasional flooding and run-in from adjacent slopes, which increases the available moisture for plant use. As a consequence, this site has the highest production potential of all the range sites. Forage production ranges between 5,000 and 11,500 pounds per acre. The soils are deep, well drained, and have a high water-holding capacity. The texture is loam to silty-clay loam in surface layers, and the soil is moderately permeable to plant roots. Generally, these soils are high in fertility and organic matter.

Small areas of clay-dominated soils may occur in this range site, but these were not distinguishable on aerial photographs.

Major decreasers in the loamy-lowland range site are primarily the tall grasses: switchgrass, Indian grass, big bluestem, and eastern gamagrass *(Tripsacum dactyloides).* The presence of important forbs, such as wholeleaf rosinweed and compassplant *(Silphium lacinatum),* are indicative of excellent range condition. However, the loamy lowland rarely maintains excellent condition because of generally close proximity to water and level topography, which encourages overgrazing. Increasers on this site

include side-oats grama, tall dropseed *(Sporobolus asper)*, buckbrush *(Symphorycarpos orbiculatus)*, and Baldwin ironweed *(Vernonia baldwinii)* (see tables 8, 9, and 10).

This range site was not mapped on the Osage study area because of extensive cultivation. In the Wabaunsee study area, some loamy lowlands were found, but most had been cultivated.

Loamy Upland (U)

The loamy-upland range site is a nearly level to rolling upland site with slopes up to 30 percent, and is the most extensive range site in all study areas. The soils of this site have a loam to silty-clay loam surface texture, usually are well granulated, and have good structure 14 inches or more in depth over fine textured subsoils. The subsurface soils vary from clay loam to clay or silty clay, have high water-holding capacity, and are moderately permeable. Some soil phases have stones on the soil surface as well as in the soil profile. The loamy-upland site occurs on various topographical levels, often alternating with the shallow-breaks site.

Major decreaser species on this site are big bluestem, little bluestem, Indian grass, and switchgrass. Under heavy grazing, side-oats grama, western wheatgrass, and tall dropseed increase. Forage production ranges between 2,500 and 7,000 pounds per acre, and varies with growing conditions, particularly soil water.

The Soil Conservation Service in Kansas uses the terms loamy upland and limy upland (calcareous to the surface; see enclosures 1 and 2), while in Oklahoma, the equivalent range site is sometimes called loamy prairie (enclosure 3).

Shallow Breaks (S)

Because of local differences in the soils and growth conditions, the forage production on this site varies between 1,500 and 6,000 pounds per acre. In many locations, growth of plant roots is restricted by shallow underlying sandstone, limestone, or shale. Other locations, however, have sufficient soil for good root development. The shallow-breaks range site is usually located on slopes that exceed 25 percent, often with blufflike topography or with narrow bands of outcropping limestone.

Most of the examples of this range site are ribbon-like, in repeating layers, and form a variegated, concentric pattern on the landscape. At ground level, the site appears to be alternating layers on the steep slopes. Intermingling shallow and deep soils, with interspersed rock fragments and often with outcroppings of limestone and shale, also characterize this site.

The site position and soil composition provide good water relationships for the vegetation.

The tall grasses are usually present in deeper soil areas and along cracks in underlying parent material. The dominant vegetation includes decreasers, such as big and little bluestem, Indian grass, and switchgrass. Under heavy grazing, the short grasses, such as hairy grama, blue grama, and perennial threeawn *(Aristida longiseta)* may increase, and annual dropseed *(Sporobolus vaginiflorus)*, annual threeawn *(Aristida oligantha)*, and annual broomweed *(Gutierrezia dracunculoides)* may invade. Woody shrubs and eastern redcedar are also common invaders on this site.

The Soil Conservation Service describes range sites such as breaks as shallow limy, very shallow, limestone breaks, and shallow upland. These are probably equivalent to shallow breaks as used herein (enclosures 1, 2, and 3), although some differences in productivity and soil profile do exist.

Riparian Forest (W)

This range site occurs on the alluvial and colluvial deposits of silt, clay, and shale along the streams, and differs little in topography from the loamy-lowland sites. The soils receive extra water from stream overflows, and a few locations have a high water table (subirrigated). Soils are similar to the loamy lowland, but may be less mature with less well developed soil profiles. Most of the riparian forests in the study areas are confined to narrow bands bordering major streams and drainages; some may represent loamy lowlands that have been overutilized and have reverted to timber. Classification of this site was dependent mostly upon the density of woody vegetation in the appropriate habitat.

Tree species common to this site include sycamore *(Platanus occidentalis)*, bur oak *(Quercus macrocarpa)*, green ash *(Fraxinus pennsylvanica lanceolata)*, American elm *(Ulmus americana)*, and cottonwood *(Populus deltoides)*. Most of the American elm have been killed by Dutch Elm disease *(Ceratocystis ulmi)*. The understory may consist of tall grasses, such as big and little bluestem, switchgrass, and Indian grass, and the wildryes *(Elymus spp.)*. Forage production of usable forage depends upon local conditions, such as frequency of flooding and density of trees, and is often of limited value for livestock grazing.

Upland Forest (F)

This site often occurs near riparian forests, particularly on the slopes of the hills immediately adjacent to a river or creek. The slopes are usually 15 to 25 percent; the soils are shallow and are composed of colluvial materials that contain fragments of shale, limestone, and chert. Most of these woodlands occur on the north-facing slopes, but some occur on west-facing slopes. There is little ground cover because the high density of trees has a closed canopy and thus shades the solid surface.

The vegetation consists primarily of several species of oak, elm, hickory, and some eastern redcedar.

On the Wabaunsee study area, there were a few examples of the upland forest site that were too small to map, and were included in the riparian forest on the range-site maps.

Cross Timbers(T)

This range site is dominated by oaks and is located on two main types of soils classified as sandy and sandstone breaks. It occurs only on the Osage study area (table 7).

The sandstone-breaks type consists of rough stony land with large boulders on the sandstone outcrops and slopes of 30 to 60 percent. The water penetrability is limited and there is a high degree of erosion. The vegetation consists of open-canopy stands of post oak *(Quercus stellata)*, blackjack oak *(Q. marilandica)*, some hickory *(Carya spp.)*, and a ground cover of little and big bluestem, broomsedge *(Andropogon virginicus)*, Indian grass, and wildrye.

The sandy to sandy-loam soil type generally has slopes of 2 to 30 percent. These soils are shallow to deep, well drained, and allow water to infiltrate readily. The dominant vegetation consists of post oak, blackjack oak, and hickory, while the ground cover consists of broomsedge, big bluestem, little bluestem, switchgrass, and wildryes.

Understory forage production is good when there is adequate precipitation and varies between 800 and 5,000 pounds per acre.

The Soil Conservation Service has described several range sites including cross timbers and savanna (enclosure 3). However, these range sites were not distinguishable on aerial photographs and thus were mapped herein only as cross timbers.

For detailed descriptions of other range sites present in the area of the study but not mapped or described for the study areas, see enclosures 1, 2, and 3.

Prairie Hay (H)

This category includes all areas with photographic evidence indicating recent mowing of native vegetation for hay. In the Wabaunsee and Osage areas, most of the prairie hay is harvested from the loamy-upland range site. Small sections of loamy lowland are also used as haylands.

These fields are ungrazed during the spring and early summer months, after which they are mowed and baled for winter feed. The cattle may graze such areas after mowing if there has been adequate rainfall. The dominant grass species for this site are big and little bluestem, switchgrass, and Indian grass, but species composition varies depending upon the timing and frequency of haying operations. Hayed locations typically have a paucity of forb and woody species. However, since this site has not been tilled, the climax-species composition is still mostly intact, and the recovery potential is high.

Tame Pasture (M)

This site is located only within the Osage study area and consists of pastures that are intensively managed for grazing livestock. There is intensive manipulation of grazing in these pastures with frequent cultural treatments, such as tillage, seeding of exotic grasses – usually bermudagrass *(Cynodon dactylon)* – and frequent application of fertilizers and pesticides. This provides supplementary forage for the native range. Tame pastures are mostly potentially loamy upland.

Go-Back Areas (G)

Go-back is a colloquial term that is synonymous with secondary autogenic succession. These are locations where the prairie sod was plowed for agricultural purposes, and later abandoned. Such fields have undergone various durations of secondary succession and are usually characterized by a dominance of annual grasses, especially annual threeawn. However, the exact species composition is dependent upon the treatment prior to, and the length of time succeeding, abandonment.

A discussion about recovery potential will be included later, which will be particularly applicable to go-back sites and the successional processes.

Agriculture (A)

Agricultural lands include actively cultivated and fallow fields, perennial legume crops – primarily alfalfa *(Medicago sativa)* – and human-habitation areas. The major portions of the agricultural lands in the study areas were historically, and would probably be potentially, loamy-lowland and associated loamy-upland range sites.

METHODS AND PROCEDURES

The range-site survey began December 1, 1974. Aerial photographs of each of the three study areas were overlain with frosted acetate material. Wabaunsee and Chase study area photos were Agricultural Stabilization and Conservation Service, 9" x 9", 1:21120, and Osage study area photos were 1:42240. Section corners were located and marked on the overlay material. The initial ground reconnaissance occurred December 19-22, 1974. The Wabaunsee study area was visited first, then the Chase and Osage study areas.

All the public roads in each area were traveled, observing range-site characteristics visible along the road. Ground evidence (species, topography, etc.) was correlated with photo densities and patterns. At this time, most of the categories of range sites that would be mappable were established within time and travel constraints.

The next step was actually mapping of the sites on photographs. This was done in the laboratory by extrapolating to the overlays the information obtained while traveling along the roads in each study area, and by obtaining technical range-site descriptions from the Soil Conservation Service and others (see references, and enclosures 1, 2, and 3).

The overlay range-site maps were transferred to the 7.5′ quadrangle series scale (1:24,000) by Vertical Sketchmaster. Considerable lateral distortion occurred in the transfer, causing significant map error. Where possible, these errors were corrected by correlating range-site boundaries with the topographic map's contour lines.

The second ground reconnaissance was March 15-17, 1975, with the same itinerary as the first trip. Additional data was gathered for use in mapping procedures. The aerial photographs and maps were of a relatively small scale, access to most of the locations was limited, and over 275,000 acres were to be mapped within a 6-month time period; thus, the range-site maps are necessarily of low resolution. More accurate mapping of range sites would require ground access to the areas that were to be mapped, and consequently would require much more time. These two factors, time and study-area access, made it impossible to map the less common and more localized range sites previously mentioned. Final range-site maps were inked on reproducible, film-type topographic bases of the 7.5′ quadrangle series scale. Areal extent of each of the range-site types was estimated using the dot-count method.

Two main categories of sites were obvious from the mapping procedures: *uncultivated* native rangeland, including prairie hay, and sites that were currently or at some time *cultivated,* including tame pastures. Most cultivated lands in the study areas are relatively flat, with deep fertile soil, and of sufficient size to be farmed. Rangeland usually has more relief and/or shallower soils than farmland. Extrapolations from surrounding range sites and topographic position of cultivated locations were used as keys to identify the potential range sites that cultivated areas might revert to if they were abandoned. It should be pointed out that potential range-site categories are theoretical. There is no empirical evidence indicating that a potential range site will be restored once a grassland has been plowed or otherwise significantly disturbed.

DESCRIPTION OF STUDY AREAS

WABAUNSEE

General

The Wabaunsee study area, covering about 79,000 acres, is located in the southwest corner of Wabaunsee County, Kansas. The county seat, Alma, lies at the northern apex of the study area. Alma is approximately 30 miles west-southwest of Topeka, Kansas.

The Wabaunsee study area is characterized topographically by a series of east-facing limestone escarpments that are considerably dissected by streams lined with rock ledges. These stream areas and the adjacent slopes are mostly wooded.

Vegetation in the Wabaunsee area is typical of the Flint Hills tallgrass prairie. The dominant grasses of this area are big bluestem, little bluestem, switchgrass, and Indian grass. The soils in the Wabaunsee area have developed from Permian limestone and shale, as well as Quaternary alluvium.

Climate

The Wabaunsee study area has a typical continental climate. The mean annual temperature is +55°F (see figure 1). Recorded extremes are -21°F and +115°F. The mean annual precipitation is 34 inches, with 70 percent of the rain falling during the 6-month growing season, April through September (see figure 2). Precipitation has varied from 23 to 53 inches annually.

In the summer, the rate of evaporation is high and the relative humidity is low (see figure 3). During the winter (November through April), snowfall has averaged 18 inches.

Geology and Soils

Geological formations in the Wabaunsee study area are of Permian age with the Wreford limestone, Matfield shale, and the Barneston formations forming the outcropping sequence (see table 1).

The Barneston limestone formation occurs on the ridgetops and summits. Soils formed on the limestone members (Fort Riley and Florence) of this formation are usually shallow and rocky or cherty. Most upland soils have formed on the Oketo shale of this formation.

Below the Barneston formation lies the Matfield shale formation. The soils resulting on this parent material are characterized by moderately deep soil horizons over the Blue Springs or Wymore shale members. These deeper soils have resulted from the accumulation of alluvial materials eroded from the easily decomposed shales. See table 2 for the soil series resulting from the parent materials, formations, and members.

The lowest outcrop formation in the Wabaunsee area is the Wreford limestone, which is characterized by a shale layer (Havensville shale) between two cherty limestone layers (Schroyer limestone and Threemile limestone). Soils on the deeper parts of this formation are loamy in nature.

The erosion and deposition of the topsoil from the upper slopes of this formation provide the parent material for the soils on the floodplains and stream terraces along the major streams.

Figure 1. Mean monthly temperature for the Wabaunsee study area.

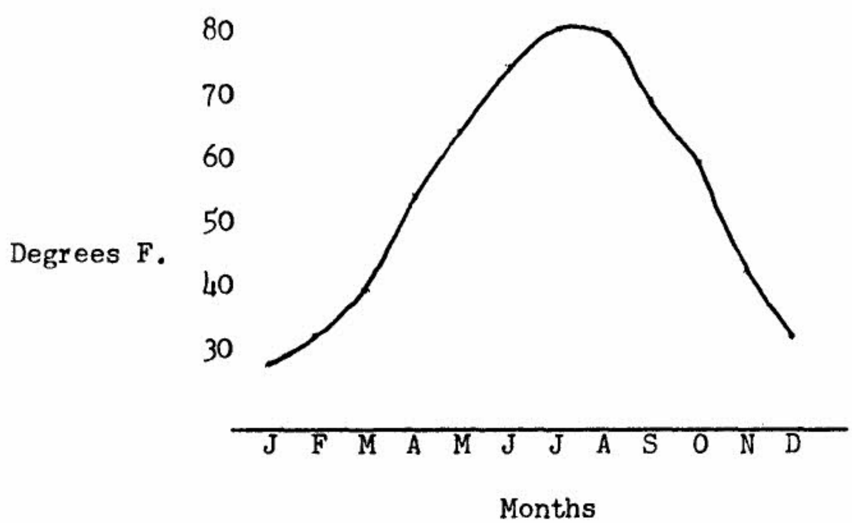


Figure 2. Mean monthly precipitation for the Wabaunsee study area.

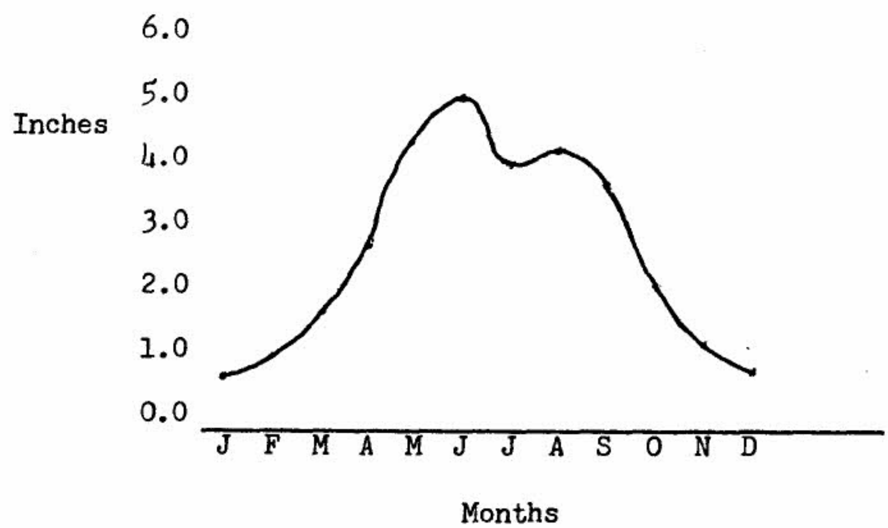


Figure 3. Mean monthly evaporation for the Wabaunsee and Chase study areas.

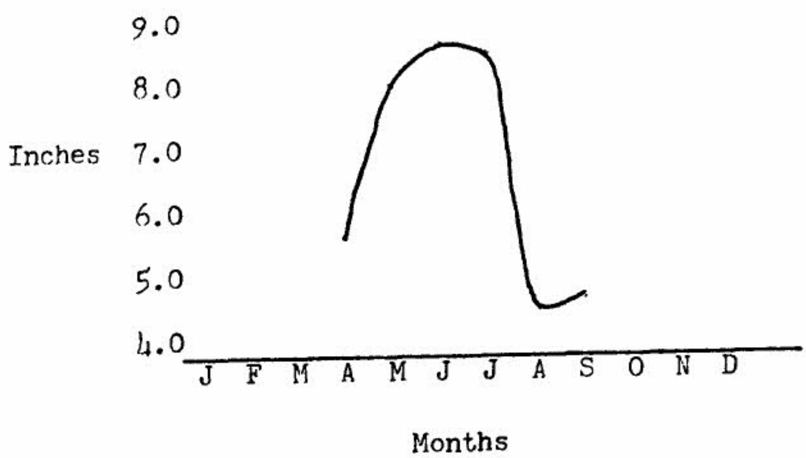


Table 1. Geologic groups, formations, and members of the Wabaunsee and Chase study areas.

Permian deposits:

Chase group

Doyle shale formation

Holmesville shale member

Barneston limestone formation

Fort Riley limestone member
Oketo shale member
Florence limestone member

Matfield shale formation

Blue Springs shale member
Kinney limestone member
Wymore shale member

Wreford limestone formation

Schroyer limestone member
Havensville shale member
Threemile limestone member

Council Grove group

Speiser shale formation
Funston limestone formation
Blue Rapids shale formation

Crouse limestone formation

Early Creek shale formation

Bader limestone formation

Middleburg limestone member
Hooser shale member
Eiss limestone member

Sterns shale formation

Beattie limestone formation

Morrill limestone member
Florena shale member
Cottonwood limestone member

Eskridge shale formation

Grenola limestone formation

Neva limestone member
Salem Point shale member
Burr limestone member
Legion shale member
Sallyards limestone member

Roca shale formation

Red Eagle limestone formation

Howe limestone member
Bennett shale member
Glenrock limestone member

Johnson shale formation

Foraker limestone formation

Hughes Creek shale member
Americus limestone member

Admire group

Janesville shale formation

Hemlin shale member
Five Point limestone member
West Branch shale member

Quaternary deposits, unclassified by group:

Terrace deposits
Alluvium
Sanborn (found only on the Wabaunsee study area)

Table 2. **Parent materials, associated geological formations and members, and associated soil series found on the Wabaunsee and Chase study areas.**

PARENT MATERIAL	FORMATION/MEMBERS	SOIL SERIES
Cherty limestone	Florence limestone[1]	Matfield
	Schroyer limestone[2]	Florence
	Threemile limestone[2]	
	Cottonwood limestone[3]	
Limestone and Calcareous shale	Holmesville shale[4]	Clime
	Fort Riley limestone[3]	Sogn
	Oketo shale[3]	Labette
	Blue Springs shale[5]	
	Kinney limestone[5]	
	Wymore shale[5]	
	Funston limestone formation[6]	
	Blue Rapids shale formation[6]	
	Crouse limestone formation[6]	
	Easly Creek shale formation[6]	
	Middleburg limestone[7]	
	Hooser shale[7]	
	Eiss limestone[7]	
	Stearns shale formation[6]	
	Morrill limestone[3]	
	Florena shale[3]	
	Eskridge shale formation[6]	
	Neva limestone[8]	
	Salem Point shale[8]	
	Burr limestone[8]	
	Legion shale[8]	
	Sallyards limestone[8]	
	Roca shale formation[6]	
	Howe limestone[9]	
	Glenrock limestone[9]	
	Johnson shale formation[6]	
	Hughes Creek shale[10]	
	Americus limestone[10]	
	Hamlin shale[11]	
	Five Point limestone[11]	

PARENT MATERIAL	FORMATION/MEMBERS	SOIL SERIES
Shale; clayey to silty sediment	Havensville shale[2] Speiser shale formation[6] Bennett shale[9] West Branch shale[11]	Dwight Irwin Ladysmith Martin Smolan-Olpe Tully Zaar
Fluvium	Terrace deposits Alluvium	Chase Kahola Reading Hobbs Ivan
Loess, glacial outwash, and gravel deposits	Sanborn	

[1] Barneston limestone formation, Chase group
[2] Wreford limestone formation, Chase group
[3] Beattie limestone formation, Council Grove group
[4] Doyle shale formation, Chase group
[5] Matfield shale formation, Chase group
[6] Council Grove group
[7] Bader limestone formation, Council Grove group
[8] Grenola limestone formation, Council Grove group
[9] Red Eagle limestone formation, Council Grove group
[10] Foraker limestone formation, Council Grove group
[11] Janesville shale formation, Admire group

RANGE-SITE MAP, WABAUNSEE STUDY AREA *

Range Sites

The Wabaunsee study area contains 60,037 acres of the four principal range sites expected to be found in the true prairie; this is approximately 76.3 percent of the study area. Clay upland makes up 2.8 percent of the area, loamy lowland makes up less than 0.1 percent, loamy upland makes up 64.9 percent, and shallow breaks make up 8.5 percent of the study area.

The remaining 23.7 percent of the study area is made up of the range sites including disturbed and forested areas. Agricultural sites comprise about 11.8 percent of the study area, and the total of significantly disturbed sites – other than those disturbed by grazing – is 15.2 percent of the study area (see table 7). Figure 4 is the range-site map showing locations and delineations of the range sites in the Wabaunsee study area.

The soil series commonly found in each range site are listed in table 3.

The Wabaunsee study area has approximately 39 major plant species. Of these, 20 are graminoids, 16 are forbs, and three are woody and shrub-like plants (see tables 8, 9, and 10).

The forage production of this study area ranges from 1,500 to 10,000 pounds per acre. The clay upland produces 2,000 to 7,000 pounds of forage per acre, the loamy lowland, 6,000 to 10,000 pounds per acre, the loamy upland 4,000 to 6,000 pounds per acre, and the shallow breaks 1,500 to 3,500 pounds of forage per acre (see table 11).

Table 3. Soil series associated with range sites on the Wabaunsee and Chase study areas.

	RANGE SITES				
	Claypan	**Clay Upland**	**Loamy Lowland**	**Loamy Upland**	**Shallow Breaks**
	Dwight	Irwin	Alluvial land	Clime	Clime
	Irwin	Labette	Chase	Florence	Florence
SOIL	Ladysmith	Ladysmith	Hobbs	Labette	Sogn
SERIES		Martin	Ivan	Martin	Stony steep land
		Tully	Kahola	Olpe	
		Zaar	Reading	Reading	
				Smolan	
				Sogn	
				Tully	
				Matfield	

CHASE

General

The Chase study area encompasses approximately 100,000 acres, and is located in northeastern Butler, southeastern Chase, and northwestern Greenwood counties. The northern boundary is the I-34 Turnpike, from the Matfield Green service area to the intersection with the Township 21 South line. The study area then extends southward to a line approximately 12 miles south of the Greenwood/Chase county line.

The land is generally uniform, consisting of rolling hillsides and relatively flat upland areas. The major diversity in topography occurs along or near the larger streams of the region, particularly those of the west branch of Fall River, the south fork of the Cottonwood River, and the Verdigris River. These watersheds are divided by the Flint Hills Ridge, which extends through the study area.

Expanses of prairie and sparsely wooded valleys are typical of the Chase study area, with the greater portion consisting of rolling and level uplands. Agricultural croplands are located on the floodplains and lowlands of the major streams.

Climate

The Chase study area is located in the 30-34 inch precipitation zone. Seventy percent of this precipitation falls during the April through September growing season (see figure 5). Heavy localized precipitation may be the result of thunderstorms during the warmer seasons. Strong winds, hailstones, and tornados may also accompany these storms.

The mean annual temperature for the Chase study area is approximately 55°F. Mean monthly temperatures are given by figure 6.

Snowfall averages 17 inches per year, with each snow cover usually melting within a week. Prevailing winds are southerly, and surface winds are light to moderate in all seasons, but increase during the spring.

Geology and Soils

The general slope of the land surface in the Chase study area is easterly; the rockbeds dip westward, with younger rocks found in the western sections of the area, and the older in the east. The older strata found along the Verdigris River in the easterly section of the Chase study area include the Council Grove group, including outcroppings of the Foraker limestone and Eskridge shale formations.

Cut by Thurmond and Little Cedar Creeks and the south fork of the Cottonwood are newer members of the Council Grove group, primarily members of the Beattie limestone, Easly Creek shale, and Funston limestone formations. These members may

Figure 5. Mean monthly precipitation for the Chase study area.

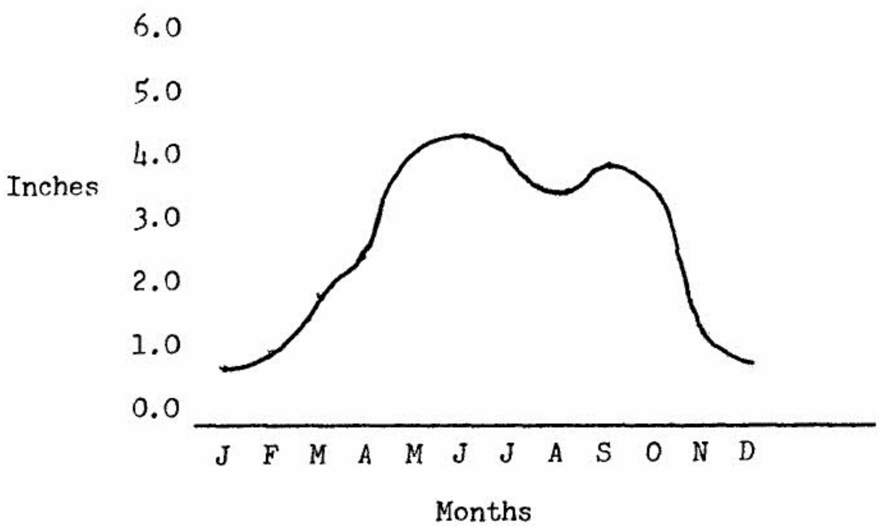
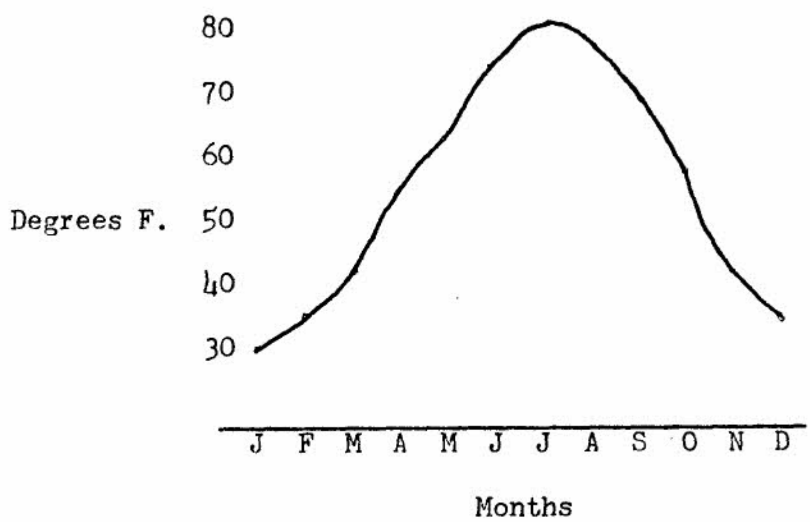


Figure 6. Mean monthly temperature for the Chase study area.



also be found above the older formations of the Council Grove group on the Verdigris and Fall River drainages.

Newer formations, of the Chase group, are encountered as the upland and ridge areas are approached. First to be observed are outcroppings of the Wreford limestone. Located higher altitudinally and geologically are members of the Matfield shale formation from which the Blue Springs shale occasionally outcrops.

Finally, the summits and ridges are capped by the Barneston limestone formation. Most common within this formation is the Florence limestone member, which has a high percentage composition of chert, and which forms a well-marked bench in the landscape. Outcroppings are frequent and easily identifiable from the amount of chert they contain. A shallow bed, the Oketo shale member, produces rocky breaks around the most prominent points in the Chase area; these are capped by the chalky Fort Riley limestone member.

The pattern of range sites in the Chase study area is influenced by the underlying strata. The shale-limestone-shale deposition has had obvious influence upon the formation of the various soil series. The result is a repeating series of gently sloping, steep, and level sites.

Table 1 lists the geologic strata found in the Chase study area. See table 2 for a list of parent materials, geologic formations and members, and associated soil series. Table 3 lists the soil series found in each range site.

Range Sites

The Chase study area contains 94,062 acres of the four principal range sites expected to be found in the true prairie; this is approximately 91.7 percent of the study area. Clay upland makes up 11.9 percent of the study area, loamy lowland 5.8 percent, loamy upland 53.8 percent, and shallow breaks 20.3 percent.

The other range sites, including disturbed and forested sites, make up the remaining 8.3 percent of the study area. Agricultural sites comprise about 2.2 percent of the study area, and the total of significantly disturbed sites, other than those disturbed by grazing, is 3.0 percent (see table 7).

The Chase study area has approximately 38 major plant species. Of these, 15 are graminoids, eight are forbs, and 15 are woody and shrub-like plants (see tables 8, 9, and 10).

The forage production of this study area varies from 1,000 to 10,000 pounds per acre. The clay upland produces 2,000 to 8,000 pounds of forage per acre, the loamy lowland 6,000 to 10,000 pounds per acre, the loamy upland 3,500 to 6,500 pounds per acre, and the shallow breaks 3,500 to 6,000 pounds per acre (see table 11).

Table 3 gives the range sites and the associated soil series for the Chase study area. Figure 7 is the range-site map delineating the range sites in the Chase study area.

Appendix B includes more detailed range-site descriptions for the Chase study area. It also includes some range sites not described in this report. This is due to low resolution, and the inability to determine and delineate all of these range sites without extensive field examinations. These range sites have been included with other described and delineated range sites.

OSAGE

General

The Osage study area is located in the Osage Hills and the southern portion of the Chautauqua Hills in north central Osage County, Oklahoma; the southeastern tip of Cowley County, Kansas; and the southwestern tip of Chautauqua County, Kansas. Surrounding towns are Cedar Vale, Kansas, 3 miles north of the study area, and Foraker, Oklahoma, 1 mile west. Larger cities that are relatively close to the study area are Wichita, Kansas, and Tulsa, Oklahoma.

The rolling hills and plateau region of the study area are covered with tall grasses, while the streams and sandstone outcrops add variety by supplying riparian forest and cross-timbers range sites.

The general slope of the study area is from the west to the east. The west side has a general elevation of 1,300 feet; the highest elevation is 1,370 feet. The east side has a general elevation of 900 feet; the lowest elevation is about 840 feet. The west side consists of a plateau, the northwest side of which has deep cutting creeks. The northeastern portion of the study area has the most agriculture, because this area is level to gently sloping, and has a good supply of water from the Caney River and its tributaries. The remainder of the study area consists of the gently rolling hills and meandering streams typical of the region.

Climate

The climate of the Osage study area is characterized by hot dry summers and wet springs and autumns. Annual precipitation averages approximately 36 inches (figure 8).

Summer temperatures are usually high, with frequent extremes of over 100°F (figure 9). The average length of the growing season is 215 days. Winter temperatures are relatively mild, with 0°F temperatures occurring infrequently.

Snowfall in the study area is not a major source of precipitation. Monthly evaporation rates for the study area are given in figure 10.

RANGE-SITE MAP, CHASE STUDY AREA *

Figure 8. Mean monthly precipitation for the Osage study area.

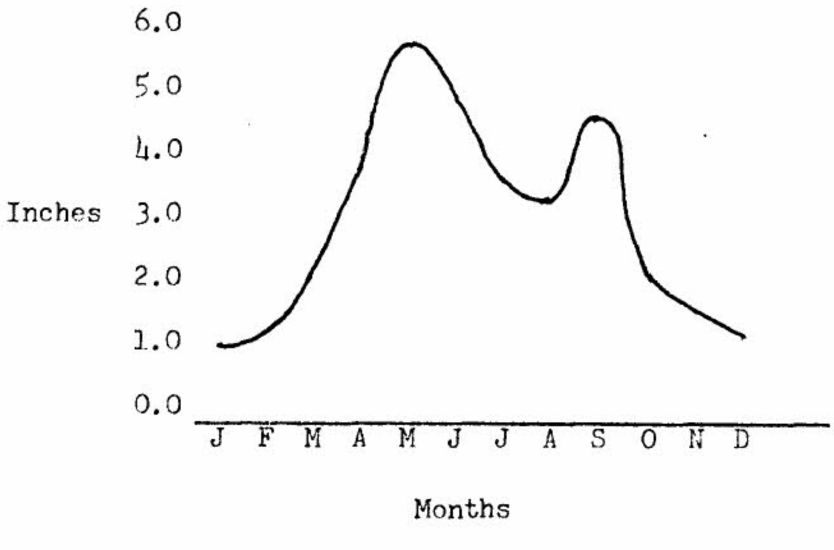


Figure 9. Mean monthly temperature for the Osage study area.

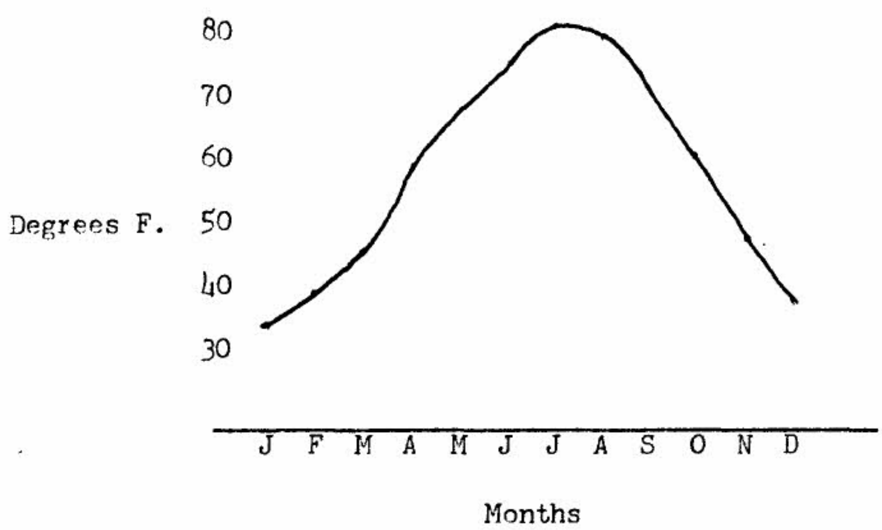
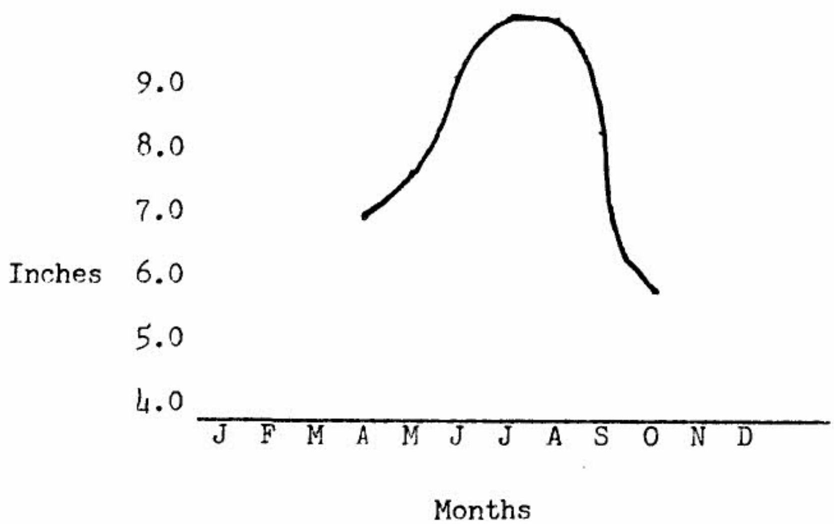


Figure 10. Mean monthly evaporation for the Osage study area.



Geology and Soils

The Osage study area is underlain by sandstone, limestone, and shale rocks of the late Pennsylvanian and early Permian periods (table 4).

Soil series such as Bates, Collinsville, and Darnell have developed from weathered sandstone while Sogn and Summit soils formed from weathered limestone. The main groups of the Permian period are the Council Grove and Admire; the only representative groups of the Pennsylvanian period are the Wabaunsee and Shawnee.

The Admire beds are non-classified beds of the Admire group. These beds are a mixture of shale, sandstone, siltstone, and limestone. They lie between Pennsylvanian rock and Foraker formation Permian rock.

The Quaternary beds present are alluvial sediments that were deposited in the upper Cenozoic era. These sediments have been modified by erosion and deposition along the streams of the study area.

Table 4 lists the geologic periods, groups, formations and members found in the Osage study area and nearby areas. The parent materials, associated geological strata, and associated soil series are given in table 5.

Range Sites

The Osage study area contains 78,628 acres (80.4 percent of the study area) of the four principal range sites expected to be found in the true prairie. Clay upland makes up 19.0 percent of the study area, loamy upland 47.6 percent, and shallow breaks 13.9 percent.

The remaining 19.6 percent of the study area is made up of the range sites that include disturbed and forested areas. Agricultural lands comprise about 4 percent of the study area. Significantly disturbed sites, other than those disturbed by grazing, comprise 5.7 percent of the study area (see table 7).

Table 6 shows soil series associated with range sites on the Osage study area. Figure 11 is a range-site map of the Osage study area.

The Osage study area has approximately 56 major plant species. Of these, 27 are graminoids, 12 are forbs, and 17 are woody and shrub-like plants (see tables 8, 9, and 10).

The forage production of this study area ranges from 1,000 to 11,500 pounds per acre. The clay upland produces 1,200 to 5,000 pounds of forage per acre, the loamy upland 2,500 to 7,000 pounds per acre, the loamy lowland 5,000 to 11,500 pounds per acre, and the shallow breaks 1,000 to 3,000 pounds per acre.

Table 4. Geologic periods, groups, formations, and members of the Osage study area.

Early Permian Period

Council Grove group

Foraker limestone formation

Hughes Creek limestone member
Americus limestone member

Admire group

Janesville shale formation

Hamlin shale member
Five Point limestone member

Late Pennsylvanian Period

Wabaunsee group
Wood Siding formation

Brownsville limestone member
Pony Creek shale member
Grayhorse limestone member
Nebraska City limestone member

Root shale formation

French Creek shale member
Jim Creek limestone member
Friedrich shale member

Stotler limestone formation

Grandhaven limestone member
Dry shale member
Dover limestone member

Willard shale formation

Emporia limestone formation

Elmont limestone member
Harveyville shale member
Reading limestone member

Severy shale formation

Auburn shale formation

Shawnee group

Deer Creek limestone formation

Ervine Creek limestone member

Lecompton limestone formation

Avoca limestone member
King Hill shale member
Beil limestone member

Oread limestone formation

Platts Mouth limestone member
Leavenworth limestone member

Vamoosa formation

Elgin sandstone member

Table 5. **Parent materials, associated geological formations and members, and associated soil series found on the Osage study area.**

PARENT MATERIALS	FORMATION/MEMBER	SOIL SERIES
Cherty limestone	Platts Mouth limestone[1]	Shidler
	Hughes Creek limestone[2]	Whizbang
Limestone and calcareous shale	Americus limestone[2]	Apperson
	Hamlin shale[3]	Foraker
	Five Point limestone[3]	Parsons
	Brownville limestone[4]	Summit
	Grayhorse limestone[4]	Whizbang
	Nebraska City limestone[4]	Sogn
	Jim Creek limestone[5]	
	Grandhaven limestone[6]	
	Dry shale[6]	
	Dover limestone[6]	
	Willard shale Fm[7]	
	Elmont limestone[8]	
	Reading limestone[8]	
	Church Creek limestone[14]	
	Ervine Creek limestone[9]	
	Avoca limestone[10]	
	King Hill shale[10]	
	Beil limestone[10]	
	Wakaruse limestone[13]	
	Leavenworth limestone[1]	
Shale (clay sediments) and clayey to very sandy sediments	Pony Creek shale[4]	Dennis
	French Creek shale[5]	Foraker
	Friedrich shale[5]	Norge
	Auburn shale Fm[7]	Okemah
	Harveyville shale[8]	Parsons
		Steedman
		Summit
Shale and sandy sediments	Soldier Creek shale[12]	Bates
	Severy shale Fm[7]	Darnell
	Elgin sandstone[11]	Dennis
		Parsons
		Stephenville
		Collinsville

PARENT MATERIALS	FORMATION/MEMBER	SOIL SERIES
Fluvium	Alluvium[15]	Mason Oakwood Verdigris

---

1 Oread limestone formation, Shawnee group, late Pennsylvanian period.
2 Foraker limestone formation, Council Grove group, early Permian period.
3 Janesville shale formation, Admire group, early Permian period.
4 Wood Siding formation, Wabaunsee group, late Pennsylvanian period.
5 Root shale formation, Wabaunsee group, late Pennsylvanian period.
6 Stotler limestone formation, Wabaunsee group, late Pennsylvanian period.
7 Wabaunsee group, late Pennsylvanian period.
8 Emporia limestone formation, Wabaunsee group, late Pennsylvanian period.
9 Deer Creek limestone formation, Shawnee group, late Pennsylvanian period.
10 Lecompton limestone formation, Shawnee group, late Pennsylvanian period.
11 Vamoosa formation, Shawnee group, late Pennsylvanian period.
12 Late Pennsylvanian period.
13 Wabaunsee group, late Pennsylvanian period.
14 Howard formation, Wabaunsee group, late Pennsylvanian period.
15 Quaternary system.

Table 6. Soil series associated with range sites on the Osage study area.

	RANGE SITES						
	Clay Upland	Cross Timbers	Loamy Lowland	Loamy Upland	Riparian Forest	Shallow Breaks	Upland Forest
SOIL SERIES	Foraker	Bates	Mason	Apperson	Mason	Shidler	Stephenville
	Parsons	Darnell	Oakwood	Bates	Oakwood	Steedman	Darnell
	Shidler	Dennis	Verdigris	Dennis	Verdigris	Summit	Steedman
	Steedman	Parsons		Foraker		Whizbang	Stephenville
	Summit	Stephenville		Norge		Sogn	
	Dwight			Okemah		Collinsville	
				Parsons			
				Summit			

RANGE-SITE MAP, OSAGE STUDY AREA *

SUMMARY

As seen in table 12, some study areas do not have all of the described and mapped range sites within their boundaries. For the Wabaunsee study area, claypan range site was included in the clay upland, no cross timbers were present, and the upland-forest range site was included in the riparian forest. The Chase study area did not have any cross timbers or upland forest designated. The Osage study area was the only study area to include both cross timbers and riparian forest, although no claypan or loamy lowland was mapped; claypan was included in the clay-upland range site, and the loamy upland was disturbed by agricultural uses.

Of the four major range sites, the loamy upland is the predominant range site in each study area. It is 64.9, 53.8, and 47.6 percent of the Wabaunsee, Chase, and Osage study areas, respectively. The other three major range sites make up 11.3, 38.0, and 32.9 percent of the Wabaunsee, Chase, and Osage study areas, respectively.

Forest range sites make up 8.6, 4.9, and 14.1 percent of the Wabaunsee, Chase, and Osage study areas, respectively.

Acreages that have been significantly disturbed by activities or influences other than grazing are 15.2, 2.9, and 5.5 percent of the Wabaunsee, Chase, and Osage study areas, respectively.

Tables 8, 9, and 10 indicate that the Osage study area has more major plant species than the other two study areas. There are 20, 15, and 27 major graminoid species in the Wabaunsee, Chase, and Osage study areas, respectively. The Wabaunsee, Chase, and Osage study areas have 16, 8, and 12 major forb species, respectively. There are also 3 major woody and shrub-like species in the Wabaunsee study area, 15 in the Chase study area, and 17 in the Osage study area.

The discussion of numbers of plant species and tables 8, 9, and 10 may be a bit misleading, because complete plant lists were unavailable for the Wabaunsee and Chase study areas. However, because the Osage study area is the most southerly area, as well as an ecotone between the bluestem prairie and the cross timbers (Kuchler 1964), it would be expected to have a more diverse flora and a greater number of plant species.

TABLE 7. Range site and potential range site (indented and in parentheses) acreage estimates for the three study areas. Percentages given are of total for a given study area. The symbol I means that for that study area the range site in question has been included in another range site. The symbol that is given after the I refers to the range site within which the inclusion was made.

	Wabaunsee Study Area		Chase Study Area		Osage Study Area	
Range Site	Acres	Percent	Acres	Percent	Acres	Percent
Claypan (P)	IC		398	.1	IC	
Clay Upland (C)	2,214	2.8	12,186	11.9	18,547	19.0
Loamy Lowland (L)	50	.1	5,910	5.8	IA	
Loamy Upland (U)	51,111	64.9	55,136	53.8	46,492	47.6
Shallow Breaks (S)	6,662	8.5	20,830	20.3	13,589	13.9
Riparian Forest (W)	6,741	8.6	5,036	4.9	4,151	4.2
Cross Timbers (T)	none		none		4,233	4.3
Upland Forest (F)	IW		none		5,404	5.5
Agriculture (A)	9,317	11.8	2,216	2.2	3,680	3.8
clay upland (HC)	(207)		104		none	
loamy lowland (HL)	(6,900)		813		3,115	
loamy upland (HU)	(2,210)		1,189		550	
riparian forest (AW)	(IAL)		110		15	
Prairie Hay (H)	2,434	3.1	73	.1	605	.6
clay upland (HC)	(69)		none		12	
loamy lowland (HL)	(150)		22		32	
loamy upland (HU)	(2,215)		51		544	
upland forest (F)	(none)		none		17	
Go-back (G)	205	.2	778	.8	378	.4
clay upland (GC)	(25)		158		none	
loamy upland (GU)	(180)		620		378	
Tame Pasture (M)	none	.0	none	.0	672	.7
loamy lowland (ML)	(none)		none		99	
loamy upland (MU)	(none)		none		573	
TOTAL	**78,734**		**102,563**		**97,751**	

Table 8. Major graminoid plant species found on each range site within the study areas.

Species	WABAUNSEE STUDY AREA Range Sites					CHASE STUDY AREA Range Sites						OSAGE STUDY AREA Range Sites						
	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Claypan	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Cross Timbers	Upland Forest
Graminoids																		
Agropyron smithii (In)*	X	X				X	X		X				X	X				
Andropogon gerardi (De)**	X	X	X	X			X	X	X	X	X	X	X	X	X		X	
Andropogon saccharoides (In)	X			X								X	X	X	X		X	
Andropogon scoparius (De)	X		X	X		X	X			X		X	X	X	X		X	
Andropogon virginicus (De)														X	X		X	
Aristida oligantha (In)+	X			X		X	X		X									
Bouteloua curtipendula (In)	X	X	X	X		X	X	X	X	X		X		X	X			
Bouteloua gracilis (In)	X	X	X			X	X	X	X	X		X		X	X			
Bouteloua hirsuta (In)				X						X		X			X			
Bromus spp. (In)	X		X	X	X	X	X		X				X	X			X	
Buchloe dactyloides (In)	X		X	X		X	X		X	X		X	X		X			
Carex spp. (In)		X		X	X	X	X	X				X	X	X				
Cenchrus pauciflorus												X						
Chloris verticillata (In)															X			
Cynodon dactylon (In)												X	X	X				
Echinochloa crusgalli (In)		X																
Elymus spp. (De)													X					
Elymus canadensis (De)		X			X		X	X			X							
Elymus virginicus (De)		X			X						X							
Leptoloma cognatum (?)														X			X	
Panicum scribnerianum (In)														X			X	
Panicum virgatum (De)	X	X	X	X		X	X	X	X	X	X		X	X			X	
Paspalum floridanum (In)													X					X
Poa pratensis (In)	X	X			X			X	X									
Setaria geniculata (In)													X					
Setaria lutescens												X	X	X	X		X	
Sorghastrum nutans (De)	X	X	X	X			X	X	X	X	X	X	X	X			X	
Spartina pectinata (De)													X					X
Sporobolus asper (De)	X	X	X			X	X	X	X	X		X	X	X			X	
Sporobolus asper hookeri (De)		X		X									X		X			
Sporobolus cryptandrus (In)															X		X	X
Trypsacum dactyloides (De)		X															X	X
Subtotals	13	14	9	12	5	10	13	9	11	9	5	13	17	16	12		13	4

*Increaser
**Decreaser
+Invader

Tab[redacted] Major [redacted] pl[redacted] s[redacted]es fo[redacted] on [redacted]ch range s[redacted] within the [redacted]dy ar[redacted].

Species	WABAUNSEE STUDY AREA Range Sites					CHASE STUDY AREA Range Sites						OSAGE STUDY AREA Range Sites						
	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Claypan	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Cross Timbers	Upland Forest
Forbs																		
Ambrosia psilostachya (In)*	X		X	X		X	X	X				X	X	X	X		X	
Aster ericoides (In)	X	X	X											X			X	
Baptisia spp. (De)**												X		X			X	
Carduus nutans (In)+		X	X															
Croton texensis (In)				X								X		X	X		X	
Desmanthus illinoensis (De)													X	X			X	X
Echinacea angustifolia (De)			X	X														
Galium aparine																X	X	X
Gutierrezia dracunculoides (In)	X		X	X								X	X	X			X	
Gutierrezia sarothrae						X	X		X									
Helianthus spp. (De)++			X	X	X								X	X		X	X	X
Lespedeza capitata (De)			X						X									
Petalostemum purpureum (De)	X		X				X		X	X								
Psoralea tenuiflora (In)	X					X	X		X			X		X	X		X	
Salvia azurea		X	X									X		X	X		X	
Silphium integrifolium (De)	X							X										
Silphium laciniatum (De)	X			X				X					X	X			X	
Solidago spp. (In)												X	X	X			X	
Solidago missioriensis (In)			X	X														
Solidago ridgida (In)			X	X														
Vernonia baldwini (In)	X							X										
Subtotals	8	3	11	8	1	3	4	4	4	1		7	6	11	4	2	12	3

*Increaser
**Decreaser
+Invader
++Exception: willowleaf sunflower (H. salicifolius) is an increaser

Table 10. Major woody and shrub-like plant species found on each range site within the study areas.

Species	WABAUNSEE STUDY AREA Range Sites					CHASE STUDY AREA Range Sites						OSAGE STUDY AREA Range Sites						
	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Claypan	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Clay Upland	Loamy Lowland	Loamy Upland	Shallow Breaks	Riparian Forest	Cross Timbers	Upland Forest
Woody & shrub-like plants																		
Acer rubrum																X		
Acer saccharinum											X							
Amorpha canescens (De)**	X		X						X	X								
Carya spp. (In)*													X			X		
Carya cordiformus																		
Ceanothus ovatus (De)			X						X	X								
Celtis occidentalis (In)											X		X			X		
Cercis canadensis																X		
Cornus asperifolia																X		
Fraxinus pennsylvanica													X			X		
Fraxinus pennsylvanica lanceolata											X							
Juglans nigra (In)											X		X			X		
Juniperus virginiana (In)																X	X	X
Platanus occidentalis (In)											X							
Populus deltoides											X		X			X		
Quercus borealis																		
Quercus macrocarpa											X					X		
Quercus marilandica (In)																	X	X
Quercus stellata (In)																	X	X
Quercus velutina																X		
Rhus aromatica (In)									X	X								
Rhus glabra (In)									X	X				X	X		X	
Salix spp.											X							
Symphoricarpos orbiculatus (In)		X				X	X	X	X			X	X	X	X	X	X	X
Ulmus americana											X		X			X		X
Ulmus pumila (In)											X					X		
Subtotals	1	1	2			1	1	1	5	4	10	1	7	2	2	14	5	7

*Increaser
**Decreaser

Table 11. Annual forage production (air-dry lbs/acre) of range sites on the study areas.

	STUDY AREAS		
	Wabaunsee	Chase	Osage
Range Sites			
Clay upland	2,000- 7,000	2,000-8,000	1,200-5,000
Loamy lowland	6,000-10,000	6,000-10,000	5,000-11,500
Loamy upland	4,000-6,000	3,500-6,500	2,500-7,000
Shallow breaks	1,500-3,500	3,500-6,000	1,000-3,000
Claypan	*	1,000-4,000	
Cross timbers			800-5,000

*The forage production for the blank cells is unknown.

Table 12. Acreage estimates and percents for range sites and potential range sites for the three study areas. The symbol I means that for that study area the range site in question has been included in another range site. The symbol that follows the I refers to the range site within which the inclusion was made.

Range Site	WABAUNSEE			CHASE			OSAGE		
	Actual	Potential	Total	Actual	Potential	Total	Actual	Potential	Total
Claypan (P)	IC	none	IC	398	none	398	IC	none	IC
Clay Upland (C)	2,214 (2.8)*	301 (.4)	2,515 (3.2)	12,186 (11.9)	262 (.3)	12,448 (12.1)	18,547 (19.0)	12 (.1)	18,559 (19.0)
Loamy Lowland (L)	50 (.1)	7,050 (9.0)	7,100 (9.0)	5,910 (5.8)	835 (.8)	6,745 (6.6)	IA	3,246 (3.3)	3,246 (3.3)
Loamy Upland (U)	51,111 (64.9)	4,605 (5.8)	55,716 (70.8)	55,136 (53.8)	1,860 (1.8)	(55.6)	56,996 (47.6)	46,492 (2.1)	48,537 (49.7)
Riparian Forest (W)	6,741 (8.6)	none	6,741 (8.6)	5,036 (4.9)	110 (.1)	5,146 (5.0)	4,151 (4.2)	15 (.1)	4,166 (4.3)
Shallow Breaks (S)	6,662 (8.5)	none	6,662 (8.5)	20,830 (20.3)	none	20,830 (20.3)	13,589 (13.9)	none	13,589 (13.9)
Cross Timbers (T)	none	none	none	none	none	none	4,233 (4.3)	none	4,233 (4.3)
Upland Forest	IW	IW	IW	none	none	none	5,404 (5.5)	17 (.1)	5,421 (5.5)
TOTAL	66,778 (84.8)	11,956 (15.2)	78,734 (100.0)	99,496 (97.0)	3,067 (3.0)	102,563 (100.0)	92,416 (94.5)	5,335 (5.5)	97,751 (100.0)

*Percent of total study area.

RECOVERY POTENTIAL

Range-condition evaluation is a time-consuming process. In order to make an accurate assessment of the range condition of any area of native grassland, it is necessary to have a detailed soils map and to make an on-the-ground check of all range sites to be evaluated. This enables technicians to estimate composition and cover of the principal species on each site, and hence to apply these data to the Soil Conservation Service *Guide for Determining Range Condition.* Because of the size of the study areas, it would take several years to accurately determine the range condition. Another more serious problem is the lack of access to the land under study; range condition cannot be determined from a roadside survey.

Fortunately, in this subhumid area of the true prairie, plant succession on grazed native pastures is very rapid. Range sites in fair condition can change to excellent condition in a relatively short period of time. Owensby (1975) reports of a range site in the Flint Hills near Manhattan, Kansas, which had a history of overgrazing for 17 years and had been reduced to fair range condition; after only 1½ years of rest, the site was restored to excellent condition. This is not an unusual happening in the true prairie. Even in the years immediately following the drought of the 1930s Weaver and Bruner (1945) found that "after eight years, and especially three consecutive good years, climax conditions had almost been attained." The return of grass species to climax composition is rapid compared to forbs. However, most forbs return in only a few years. Other authors working in true prairie have had similar results (Mentzer 1951, Weaver 1954, Penfound 1964). Because succession on grazed native prairies of fair to excellent condition is of short duration, there is very little to be gained in attempting a detailed assessment of range condition at this time.

The range condition of the Flint Hills has been evaluated by various investigators. From many years of experience and after conversations with professors at Kansas State University, Fort Hays Kansas State College, and range technicians in the field, we can make a conservative estimate that over 50 percent of the entire area of native vegetation is in good-to-excellent condition. On certain sites, such as the lowlands, the condition may be slightly lower, while on others, such as the limestone breaks, it may be higher. Therefore, the concern is not with the range condition of the native vegetation, but with the amount of land that has been cultivated.

Cultivation almost completely destroys native vegetation. Penfound and Rice (1957) found that after 5 consecutive years of plowing, all remnants of true prairie plants were destroyed. A number of studies have reported on secondary succession following cultivation in the true prairie. Penfound (1964) described several stages in succession following cultivation as follows: (1) annuals (about 3 years), (2) forb/shortgrass (about 4 years), (3) shortgrass/midgrass/tallgrass (about 8 years). After 15 years the climax vegetation speciation was not fully developed, but the potential for the climax structure was achieved. It is not certain how long the succession would take in the true prairie, but it would probably take in excess of 20 years. The rate of secondary succession on abandoned croplands could be accelerated by artificial seeding of native grasses and forbs.

In summary, it appears that in assessing the condition of the study areas, probably only two important classifications are necessary – native vegetation and cultivated land.

LITERATURE CITED

DYKSTERHUIS, E. J.

1949 "Condition and Management of Rangeland based on Quantitative Ecology." *Journal of Range Management*, 2:104-115.

KUCHLER, A. W.

1964 *Potential Natural Vegetation of the Conterminous United States* (map and manual). American Geographical Society, special publication no. 36.

MENTZER, L. W.

1951 "Studies on Plant Succession in True Prairie." Ecological Monographs, 21:255-267.

OWENSBY, C. E.

1975 Personal communication. Kansas State University, Manhattan, Kansas.

PENFOUND, W. T.

1964 "The Relation of Grazing to Plant Succession in the Tall Grass Prairie." *Journal of Range Management,* 17:256-260.

WEAVER, J. E.

1954 "A Seventeen-Year Study of Plant Succession in Prairie." *American Journal of Botany,* 41:31-38.

WEAVER, J. E., AND W. E. BRUNER

1945 "A Seven-Year Quantitative Study of Succession in Grassland." *Ecological Monographs,* 15:297-319.

REFERENCES

Anderson, K. L., and C. L. Fly
1955 "Vegetation-Soil Relationships in the Flint Hills Bluestem Pastures." *Journal of Range Management,* 8:163-169.

Beckwith, H. T.
1928 *Geology of Osage County, Oklahoma.* U.S. Geological Survey, bulletin 40-T.

Bidwell, O. W.
1966 "The Flint Hills Range Sites." *Transcripts of the Academy of Science,* 69(3-4):205-213. Kansas.

Buck, P., and R. W. Kelting
1962 "A Survey of the Tallgrass Prairie in Northeastern Oklahoma." *Southwestern Naturalist,* 7:163-175.

Bruner, W. E.
1931 "The Vegetation of Oklahoma." *Ecological Monographs,* 1:99-180.

Carter, James A.
1954 "Geology of the Pearsonia Area, Osage County, Oklahoma." Unpublished master of science thesis. University of Oklahoma.

Dwyer, D. D.
1961 *Activities and Grazing Preferences of Cows with Calves in Northern Osage County, Oklahoma.* Oklahoma Agricultural Experiment Station, bulletin B-588.

Hazell, D. B.
1960 *Forage Production, Vegetative Composition and Plant Vigor in Relation to Range Condition.* Masters thesis. Fort Hays State College, Kansas.

Jewett, J. M.
1961 "Fifth Geological Conference in the Flint Hills in Lyons, Chase, Morris, and Wabaunsee Counties." Kansas State Geological Survey.

Moore, Raymond C., J. M. Jewett, and Howard G. O'Connor
1951 "Rock Formations of Chase County." Kansas State Geological Survey, 11:1.

Neill, James T.

1974 *Soil Survey of Chase County, Kansas.* U.S. Department of Agriculture, Soil Conservation Service.

Smith, Ken, and Ellis Anders, Jr.

1951 *The Geology of Davis Rànch Oil Pool, Wabaunsee City, Kansas.* University of Kansas, bulletin 90.

Tanner, W. F.

1956 *Geology of Northeastern Osage County, Oklahoma.* Oklahoma Geological Survey, circular 40.

Tomanek, G. W.

1958 *An Analysis of Three Areas in the Flint Hills.* Prepared for the National Park Service, U.S. Department of the Interior

Tomanek, G. W., and F. W. Albertson

1959 *An Analysis of Some Grasslands in the True Prairie.* Prepared for the National Park Service, U.S. Department of the Interior.

Tomanek, G. W., G. K. Hulett, and R. A. Nicholson

1975 *Biological Inventories, Range Ecology, Three Alternative Prairie Study Areas.* Prepared for the National Park Service, U.S. Department of the Interior.

U.S. Department of Agriculture, Soil Conservation Service

n.d. "Soil Survey of Osage County, Oklahoma." Unpublished.

1959 *Soil Survey of Pawnee County, Oklahoma.*

1960 *Soil Survey of Geary County, Kansas.*

1967 *Soil Survey of Kay County, Oklahoma.*

1968a *Soil Survey of Washington County, Oklahoma.*

1968b *Range Condition Guides and Technical Range Site Descriptions for Kansas.*

U.S. Department of Agriculture, Soil Conservation Service
1970 *Soil Survey of Shawnee County, Kansas.*

- - - - -
1974 *Soil Survey of Chase County, Kansas.*

U.S. Department of Agriculture, Soil Conservation Service, and Kansas Agricultural Experiment Station
1952 *Physical Land Conditions Affecting Use, Conservation and Management of Land Resources.*

U.S. Department of the Interior, Geological Survey
n.d. *Geology of Wabaunsee County Kansas.* Geological Survey, bulletin 1068.

ENCLOSURE 1: KANSAS TECHNICAL RANGE-SITE DESCRIPTIONS FOR WABAUNSEE STUDY AREA. ADAPTED FROM *SOIL SURVEY OF SHAWNEE COUNTY, KANSAS* (1970), AND *SOIL SURVEY OF GEARY COUNTY, KANSAS* (1960).

Clay-Upland Range Site (C)

This range site may include Eram, Irwin, and Summit silty-clay soils, eroded Martin clay, and Martin silty-clay soils. Depth ranges from 7 to 14 inches. Slopes usually range from nearly level to 10 percent; 20 percent slopes are infrequent.

Clay surface soils are from 10 to 14 inches deep over fine-textured subsoils that frequently restrict the movement of water into the subsoil. Because of high water retention, these soils frequently do not release adequate amounts of water to the vegetation to maintain physiological functions for maximum forage production during stress periods. Climax vegetation is as follows:

Decreasers	Increasers	Invaders
Big bluestem	Tall dropseed	Windmillgrass
Little bluestem	Side-oats grama	Tumblegrass
Indian grass	Blue grama	Silver bluestem
Switchgrass	Western wheatgrass	Kentucky bluegrass
Prairieclovers	Slimflowered scurfpea	Annual brome
Leadplant amorpha	Western ragweed	Annual threeawn
	Heath aster	Broomweed
		All other annuals
		All exotics

Under climax condition the principal forage species found on this site are big and little bluestem, Indian grass, switchgrass, leadplant, prairieclovers, and small amounts of the increaser species. When the range condition goes down, the increasers – tall dropseed and side-oats grama – increase. Very careful grazing management is needed on this range site to maintain maximum productivity by the better forage species. This site will deteriorate to annual grasses, tall dropseed, and buckbrush when overuse is practiced over a long period of time.

The total annual yield of forage on this site will vary considerably from wet to dry years. When in climax condition, based on plot clippings yields of air-dry forage, this site will average approximately 4,500 pounds per acre, but may vary from 7,000 pounds in favorable years to 2,000 pounds in unfavorable years.

Loamy-Lowland Range Site (L)

This range site includes alluvial lands, and Chase silty clay, Hobbs silty clay, Reading silty clay, and various loam soils. These deep, permeable soils have a loam to silty-clay

loam surface with a medium to fine textured subsoil. They are high in water-holding capacity and absorb water readily. Generally they are high in fertility and organic matter content. Internal drainage is good; an excellent water/plant relationship is present.

Climax vegetation is as follows:

Decreasers	Increasers	Invaders
Big bluestem	Side-oats grama	Barnyardgrass
Indian grass	Tall dropseed	Kentucky bluegrass
Switchgrass	Western wheatgrass	Trees
Eastern gamagrass	Blue grama	Annual grasses
Canada wildrye	Sedge species	Musk thistle
Compassplant	Baldwin ironweed	
Wholeleaf rosinweed	Buckbrush	
Perennial sunflower spp.	Wooly verbena	
Indigobush	Meadow tall dropseed	
	Heath aster	

Under climax conditions decreasers produce 90 percent or more of the production, with increasers accounting for the remainder. Side-oats grama, meadow tall dropseed, tall dropseed, western ragweed, buckbrush, and Baldwin ironweed will increase rapidly on this site when it is overused. Severe overuse causes trees and Kentucky bluegrass to move in rapidly.

This is the highest producing range site in the 30 to 34 inch annual precipitation zone. The total annual yield of this site when in climax condition, based on plot clippings of air-dry forage, will average approximately 8,000 pounds per acre, but may vary from about 10,000 pounds in favorable years to around 6,000 pounds in unfavorable years.

Loamy-Upland Range Site (U)

This range site consists of Florence cherty soils and Labette, Martin, Summit, and Tully silty-clay soils. These soils are usually well granulated, and have good structure 14 inches or more in depth over fine-textured subsoils. The soils have a good water/plant relationship and a high water-inholding capacity. Some soils have stone phases with stone, rock, or chert on the soil surface as well as in the soil profile. Climax vegetation is as follows:

Decreasers	Increasers	Invaders
Little bluestem	Side-oats grama	Broomweed
Big bluestem	Western wheatgrass	Annual threeawn
Indian grass	Blue grama	Annual brome
Switchgrass	Buffalo grass	Silver bluestem
Prairieclovers	Tall dropseed	Musk thistle
Leadplant amorpha	Heath aster	
Jerseytea ceanothus	Western ragweed	
Perennial sunflowers	Missouri goldenrod	
Pitcher's sage	Stiff goldenrod	

The principal forage production on this site, when in climax condition, is from big bluestem, little bluestem, Indian grass, switchgrass, prairieclovers, and leadplant amorpha. When overused, side-oats grama, tall dropseed, and blue grama increase rapidly at the expense of the decreasers. Annual grasses and Kentucky bluegrass, along with forb invaders and woody invaders, replace the better grasses and forbs when grazing is severe.

Decreasers make up to 85 percent or more of the total production of the climax plant community, with increasers accounting for the remainder.

The total annual yield of this site when in climax condition, based on plot clippings, will average approximately 5,000 pounds per acre, but may vary from around 6,000 pounds in favorable years to around 4,000 pounds in unfavorable years. This range site tends to be more consistent in annual production than clay upland.

Breaks Range Site (S)

This range site consists of lime-shale escarpments, rough broken and stony land, and stony steep land. It is generally a complex of shallow and deeper soils that have rock fragments on the surface and throughout the soil profiles. The shallow phases frequently appear as very narrow horizontal bands that exhibit vertical rock outcrops on occasion. Generally the rock is broken enough so that it does not prevent water penetration and deep rooting of grasses, forbs, and shrubs. These strongly granulated, medium- to fine-textured surface soils have a good water relationship for vegetation. Climax vegetation consists of the following:

Decreasers	Increasers	Invaders
Little bluestem	Side-oats grama	Broomweed
Big bluestem	Tall dropseed	Eastern redcedar
Indian grass	Meadow tall dropseed	Annual threeawn
Switchgrass	Hairy grama	Annual plantains
Perennial sunflower spp.	Western ragweed	All other annuals
Prairieclovers	Smooth sumac	All exotics
Pitcher's sage	Sedges	
Jerseytea ceanothus	Fragrant sumac	

When in climax condition, this site produces good quantities of big bluestem, little bluestem, Indian grass, and switchgrass along with forbs and shrub decreasers. Up to 25 percent of the forage will be produced by forbs and shrub decreasers. This site should not have more than 40 percent of the current year's forage production utilized if excessive runoff and erosion are to be prevented. Woody increaser and invader species will spread rapidly on this range site when it is overused.

Shallow-Limy Range Site (S)

This range site includes Sogn silty-clay and Sogn silt soils. They average less than 10 inches in depth over limestone beds. In rolling topography the shallow areas appear as intermittent narrow, horizontal bands on the face of the landscape. The limestone beds restrict the amount of water available for plant use, and inhibit normal root development of the vegetation. Up to 20 percent of the area may consist of exposed flat rock. Climax vegetation is as follows:

Decreasers	Increasers	Invaders
Little bluestem	Side-oats grama	Broomweed
Big bluestem	Blue grama	Silver bluestem
Switchgrass	Hairy grama	Common pricklypear
Prairieclover	Buffalo grass	Annual bromes
Blacksamson echinacea	Smooth sumac	Annual threeawn
	Willowleaf sunflower	Other annuals
	Fragrant sumac	All exotics

The climax vegetation is somewhat variable due to the fluctuating soil depths that are present on this range site. On most of this range site the soil is from 5 to 10 inches deep. In climax condition, side-oats grama with some little bluestem and the forb decreasers produce 60 percent of the vegetation. When continuous overuse occurs, blue grama, buffalo grass, and hairy grama produce most of the forage. Annuals such as broomweed, annual bromes, and annual threeawn are found in large amounts when range condition is poor.

The total annual yield of this site when in climax condition, based on plot clippings of air-dry forage, will average approximately 2,500 pounds per acre, but may vary from around 3,500 pounds in favorable years to about 1,500 pounds in unfavorable years.

Limy-Upland Range Site (U)

These range sites include primarily Clime clay soils. These are moderately deep soils over calcareous shales. They range from neutral to calcareous at the surface, and they are always strongly calcareous within 10 inches of the surface. These soils have a good infiltration rate, good internal drainage, and a good water/plant relationship.

Total vegetative production in this rainfall belt is limited by the high amounts of calcium carbonate in the soil profile.

Climax vegetation consists of the following:

Decreasers	Increasers	Invaders
Little bluestem	Side-oats grama	Eastern redcedar
Big bluestem	Western wheatgrass	Annual bromes
Indian grass	Hairy grama	Annual threeawn
Switchgrass	Blue grama	Broomweed
Blacksamson echinacea	Missouri goldenrod	Texas croton
Pitcher's sage	Stiff goldenrod	All other annuals
Jerseytea ceanothus	Tall dropseed	All exotics
Leadplant amorpha	Smooth sumac	
Perennial sunflower spp.	Fragrant sumac	
Prairieclovers		

In climax condition this site has up to 25 percent of the forage produced by shrub and forb decreasers. The decreaser grasses – switchgrass, little bluestem, big bluestem, and Indian grass – along with the increaser side-oats grama, produce 60 percent of the forage. Side-oats grama and forb increasers increase quite rapidly on this site when it is continually overused. Willowleaf sunflower occurs as an increaser on some calcareous soils of a shallow nature. The invaders come in slowly on this range site, but once established are quite persistent.

The total annual yield of the climax plant community on this site, based on plot clippings of air-dry forage, will average approximately 4,500 pounds per acre, but may vary from around 5,500 pounds in favorable years to about 3,500 pounds in unfavorable years.

ENCLOSURE 2: KANSAS TECHNICAL RANGE-SITE DESCRIPTIONS FOR CHASE STUDY AREA. ADAPTED FROM *SOIL SURVEY OF CHASE COUNTY, KANSAS* (1974).

Breaks Range Site (S)
This range site is included in the shallow-breaks range site of this report. It includes only stony steep land. Areas of this range site consist of very shallow soils intermingled with deeper soils and limestone outcrops. The soils are excessively drained, and runoff is rapid. The slopes range from 30 to 50 percent. The available water capacity is low to high.

Decreasers such as big bluestem, little bluestem, Indian grass, prairieclover, and switchgrass make up about 70 percent of the plant community when this site is in excellent condition. The forb decreasers produce up to 20 percent of the total production. The major increasers are side-oats grama, tall dropseed, blue grama, hairy grama, smooth sumac, and fragrant sumac. The invaders are buckbrush, weed trees, broomweed, and a number of annual forbs.

The average annual production of air-dry forage, when this site is in excellent condition, is about 4,000 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

The steepness of the slope and the many exposed rocks hamper most management practices. Controlled burning, however, can be used to advantage on this site to obtain distribution of grazing. Chemical brush control is possible with the use of aerial spraying.

Claypan Range Site (P)
This range site is included in the clay-upland range site described in this report. It includes soils of the Dwight series and eroded Irwin and Ladysmith soils. These are deep, somewhat poorly drained to well-drained soils. The slope range is 1 to 5 percent. The available water capacity is moderate to high. The soils are droughty during periods of low rainfall, however, because the compact subsoil is slow to release water for plant use, and this restricts root development.

Decreaser grasses, such as side-oats grama, switchgrass, and little bluestem, make up about 60 percent of the plant community when this site is in excellent condition. Some increasers on this site are western wheatgrass, blue grama, buffalo grass, slimflowered scurfpea, and heath aster. The major invaders are annual threeawn, annual brome, and broomweed. Broomweed, heath aster, annual threeawn, and buffalo grass produce most of the vegetation on this site when it is in poor condition.

The average annual production of air-dry forage, when this site is in excellent condition, is approximately 2,500 pounds per acre. Approximately 80 percent of the

total annual production provides forage for cattle. This range site is frequently overgrazed because of its position in the landscape.

This site responds rather slowly to management. Improvement does not come as rapidly as on most other range sites in this county. Reseeding in "go-back" areas is feasible if the soils can be protected from grazing until the grass cover is well established.

Clay-Upland Range Site (C)
This range site includes uneroded Irwin, Ladysmith, and Zaar soils and eroded soils of the Labette, Martin, and Tully series. These are deep and moderately deep, somewhat poorly drained to well-drained soils on uplands. The slope range is 0 to 7 percent. All soils in this range site are high in available water capacity except for the eroded Labette soil, which is moderate to low in available water capacity. The soils are droughty during periods of low rainfall because the clayey subsoil is slow to release water for plant use. In years of adequate moisture and well-distributed rainfall, this is a highly productive upland range site.

Decreaser grasses make up about 75 percent or more of the plant community. The major decreasers are big bluestem, little bluestem, and leadplant amorpha. The major increasers are switchgrass, side-oats grama, tall dropseed, blue grama, slimflowered scurfpea, and western ragweed. Invaders are annual bromes, annual threeawn, buckbrush, and broomweed.

When this site is in excellent condition, the average annual production of air-dry forage is about 4,700 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle.

The vegetation on this range site responds readily to management practices, and mechanical practices can be carried out without serious difficulty. Areas in poor condition can be reseeded with the aid of a cover crop.

Limy-Upland Range Site (U)
This range site is included in the loamy-upland range site in this report. It consists only of the Clime part of the Clime-Sogn complex. The areas are on uplands. This soil is moderately well drained to well drained. The slope range is 3 to 25 percent. The available water capacity is low to moderate, but stored water is readily available for plant use.

Decreasers such as little bluestem, big bluestem, Indian grass, jerseytea ceanothus, blacksamson echinacea, and prairieclover make up about 80 percent of the plant community when this site is in excellent condition. Some increasers on this site are side-oats grama, hairy grama, willowleaf sunflower, parthenium, Missouri goldenrod,

and dotted gayfeather. The major invaders are annual bromes, broomweed, and annual threeawn. Willowleaf sunflower, hairy grama, Missouri goldenrod, annual bromes, broomweed, and annual threeawn produce most of the vegetation when this range site is in poor condition.

The average annual production of air-dry forage, when this site is in excellent condition, is about 3,000 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

The forb populations on this site sometimes give concern, and attempts are sometimes made to reduce their number. This is rarely necessary. When the forb increasers do become excessive and improvement in range condition is needed, deferred grazing gives the desired result. Chemical spraying or mowing rarely is effective for more than one season. In a few areas reseeding is necessary, and care must be taken that suitable native species are used.

Loamy-Lowland Range Site (L)

This range site consists of soils of the Chase, Ivan, Kahola, and Reading series, and of Alluvial land. The soils are on low stream terraces and floodplains. They are deep and somewhat poorly drained to well drained. The slope range is 0 to 2 percent. The available water capacity is high.

This site is seldom in excellent condition, because of its slope and general proximity to watering facilities.

Decreaser grasses make up about 90 percent of the plant community. The major decreasers are big bluestem, Indian grass, switchgrass, eastern gamagrass, wholeleaf rosinweed, compassplant, and sawtooth sunflower. Major increasers are side-oats grama, tall dropseed, sedges, ironweed, buckbrush, and western ragweed. The major invaders are annual bromes, Kentucky bluegrass, and scrub trees.

When this range site is in poor condition, buckbrush, ironweed, western ragweed, barnyardgrass, Kentucky bluegrass, and scrub trees make up most of the vegetation.

When this site is in excellent condition, the average annual production of air-dry forage is approximately 8,000 pounds per acre. Approximately 85 percent of this total annual production provides forage for cattle. This range site produces more forage than any other site in the county when it is in excellent condition.

If the vegetation on this site has deteriorated, brush control may beneeded. Spraying or mowing with brush mowers is generally effective. Controlled burning can help to maintain this site in excellent condition. Except for flooding, which may delay seedbed preparation, range seeding can be done readily on this site if a good system of cover crops is used.

After seeding, control of brush and weeds helps the grass to become established. Where feasible, this range site should be managed separately from other range sites to obtain consistent long-term yields.

Loamy-Upland Range Site (U)

This range site consists of soils of the Labette, Florence, Martin, Olpe, Smolan, Tully, and sloping soils of the Reading series. These soils are deep or moderately deep, and moderately well drained or well drained. The slope range is 1 to 15 percent. The available water capacity is low to high, but stored water is readily available for plant use. Some soils in this range site have gravel or chert fragments in the surface layer, as well as throughout the profile.

These soils are on uplands, except for the Reading soils, which are on stream terraces.

Decreaser grasses make up about 80 percent or more of the total plant community when this site is in excellent condition. The major decreasers are big bluestem, Indian grass, switchgrass, leadplant amorpha, roundhead lespedeza, and prairieclover. Major increasers are side-oats grama, tall dropseed, blue grama, smooth sumac, and western ragweed. The major invaders are annual bromes, annual threeawn, broomweed, buckbrush, and Kentucky bluegrass. When this site is in poor condition, most of the vegetation is produced by annual bromes, tall dropseed, smooth sumac, broomweed, buckbrush, and Kentucky bluegrass.

The average annual production of air-dry forage, when the site is in excellent condition, is about 5,000 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle.

Some areas on this range site are in "go-back" condition and need to be seeded to native vegetation. The seeding can best be done with the use of a cover crop a year before reseeding. Brush control is needed in some areas of this site to control buckbrush, sumac, and weed trees that have become established in excessively used areas. Occasional controlled burning will help to distribute grazing and to maintain range condition, especially on the Florence soils.

Shallow-Limy Range Site (S)

This range site is included in the shallow-breaks range site described in this report. It consists only of the Sogn part of the Clime-Sogn complex and the Labette-Sogn complex. The areas are on uplands. The soils are shallow and very shallow, and are somewhat excessively drained. The slope gradient is 1 to 12 percent. The available water capacity is low, but stored water is readily available for plant use. In places limestone is exposed on the surface.

Decreaser grasses make up about 60 percent of the plant community when this site is in excellent condition. The principal decreasers are side-oats grama, little bluestem,

blacksamson, and prairieclover. The principal increasers are hairy grama, buffalo grass, blue grama, smooth sumac, and in some areas, willowleaf sunflower.

The invaders consist mostly of annual bromes and broomweed. Broomweed, annual bromes, smooth sumac, willowleaf sunflower, and buffalo grass predominate when this range site is in poor condition.

The average annual production of air-dry forage, when this site is in excellent condition, is about 2,700 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

Brush control is needed when high populations of smooth sumac become established in overgrazed areas. Willowleaf sunflower can best be controlled by deferred grazing in areas where large numbers are present.

ENCLOSURE 3: OKLAHOMA TECHNICAL RANGE-SITE DESCRIPTIONS FOR OSAGE STUDY AREA. ADAPTED FROM *SOIL SURVEY OF KAY COUNTY, OKLAHOMA* (1967), AND *SOIL SURVEY OF WASHINGTON COUNTY, OKLAHOMA* (1968).

Loamy-Lowland Range Site (L)

This site consists of the Alluvial land part of Breaks-Alluvial land complex and soils of the Mason and Verdigris series. It is on the bottomlands of various streams. The slope ranges from nearly level to gently sloping. The soils have excellent capacity for root growth and moisture storage.

Tall warm-season grasses, chiefly big bluestem, Indian grass, eastern gama, prairie cordgrass, and switchgrass, are the dominant decreasers in the climax vegetation. Tall dropseed, meadow tall dropseed, purpletop, knotroot bristlegrass, and longspike tridens are the principal increasers. Broomsedge, ironweed, giant ragweed, snakeroot, and coralberry are the most common invaders.

A few elm, sycamore, walnut, pecan, chinkapin oak, and hackberry trees grow naturally, mainly on streambanks and in areas that are flooded frequently. The trees increase in number if the site is overgrazed for a long time. Under the trees grow shade-tolerant, cool-season plants, including Canada wildrye, Virginia wildrye, and sedges.

This is the most productive site in the area. An acre produces about 11,500 pounds of herbage (air-dry weight) in a year of favorable rainfall, and about 8,000 pounds in a year of unfavorable rainfall.

Loamy-Prairie Range Site (U)

This range site consists of soils of the Bates, Dennis, Eram, Newtonia, Okemah, and Summit series and the Breaks part of the Breaks-Alluvial land complex. These soils are moderately deep to deep. They have a loamy surface layer and a slowly permeable or moderately permeable subsoil. The slope ranges from nearly level to moderately steep.

Tall grasses, including big bluestem, Indian grass, little bluestem, and switchgrass, generally make up 80 to 90 percent of the climax vegetation. Eastern gama occurs on this site, mainly on the lower slopes of Summit soils. Decreaser legumes and forbs, including leadplant amorpha, catclaw sensitivebrier, Illinois bundleflower, compassplant, and perennial sunflower, usually grow on the better managed ranges. Meadow dropseed, Scribner panicum, side-oats grama, knotroot bristlegrass, heath aster, Missouri goldenrod, and sagewort are the principal increasers. Splitbeard bluestem, broomsedge bluestem, bitter sneezeweed, ironweed, lanceleaf ragweed, silver bluestem, threeawn, common broomweed, and western ragweed are the chief invaders.

This site produces about 7,000 pounds of herbage (air-dry weight) per acre in a year of favorable rainfall, and about 5,000 pounds per acre in a year of unfavorable rainfall.

Claypan-Prairie Range Site (C)

This range site is included in the clay-upland range site described in this report. It consists of the Parsons soil in Dwight-Parsons silt loams (0 to 1 percent slopes) and Parsons silt loam (0 to 1 percent slopes). A heavy claypan subsoil, at a depth of 8 to 16 inches, slows the absorption of water and restricts the growth of plant roots. The surface layer stays wet in a rainy season but is droughty when rainfall is below normal. Even when in excellent condition, this site is only moderately productive.

Big bluestem, little bluestem, switchgrass, and Indian grass are the dominant decreasers in the climax vegetation. Overgrazing, especially during a prolonged drought, causes rapid depletion of the more palatable vegetation. Among the increasers are meadow tall dropseed, tall dropseed, silver bluestem, knotroot bristlegrass, dotted gayfeather, and heath aster. The principal invaders are common broomweed, western ragweed, lanceleaf ragweed, bitter sneezeweed, ironweed, threeawn, Japanese brome, and broomsedge bluestem.

This site produces about 5,000 pounds of herbage (air-dry weight) per acre in a year of favorable rainfall, and about 2,500 pounds per acre in a year of unfavorable rainfall.

Shallow-Breaks Range Site (S)

This site consists of Collinsville-Talihina complex (5 to 20 percent slopes) and the Collinsville soil in Bates-Collinsville complex (2 to 6 percent slopes). These soils are on uplands, and are shallow or very shallow.

When this site is in excellent condition, the most abundant decreaser plants are little bluestem, big bluestem, Indian grass, switchgrass, leadplant amorpha, catclaw sensitivebrier, Virginia tephrosia, slender lespedeza, and ashy sunflower. The more common increasers are tall dropseed, Scribner panicum, purpletop, purple lovegrass, heath aster, and goldenrod. Invaders include broomsedge bluestem, splitbeard bluestem, ironweed, lanceleaf ragweed, western ragweed, and bitter sneezeweed. Woody plants, such as blackberry, coralberry, sumac, hawthorn, and persimmon, are common, and they thicken if overgrazing continues. It often becomes necessary to spray for brush control in order to speed recovery of the better native plants.

This site produces about 4,200 pounds of herbage (air-dry weight) per acre in a year of favorable rainfall, and about 2,500 pounds per acre in a year of unfavorable rainfall.

Shallow-Claypan Range Site (C)

This site consists of the Dwight soil in Dwight-Parsons silt loams, with 0 to 1 percent slopes. It usually is associated with the claypan-prairie site. The dense, compact clay subsoil, which is at a depth of 3 to 7 inches, is nearly impervious to moisture and roots.

When this site is in excellent condition, the vegetation is approximately 60 percent decreasers and 40 percent increasers. The dominant decreasers are little bluestem, switchgrass, big bluestem, and Illinois bundleflower. The principal increasers are meadow tall dropseed, silver bluestem, blue grama, fall witchgrass, buffalo grass, heath aster, and dotted gayfeather. Invader plants include western ragweed, bitter sneezeweed, croton, common broomweed, pricklypear, tumblegrass, windmillgrass, and threeawn.

This is the least productive site in the area. It produces about 2,500 pounds per acre of herbage (air-dry weight) in a year of favorable rainfall, and about 1,200 pounds per acre in a year of unfavorable rainfall.

Shallow-Breaks Range Site (S)

This site consists of Sogn soils (1 to 20 percent slopes), which are very shallow, stony soils, usually 10 inches or less in depth over limestone bedrock. The space for moisture storage and for root growth is very limited.

Short grasses dominate on this site. They include hairy grama, side-oats grama, and small amounts of little bluestem. Blue grama occurs occasionally along the western edge of the county but is unusual in the eastern part. Among the numerous native legumes that grow on this site are catclaw sensitivebrier, prairie acacia, Illinois bundleflower, wild alfalfa, roundhead prairieclover, white prairieclover, and purple prairieclover. Increasers include buffalo grass, tumble windmillgrass, silver bluestem, dotted gayfeather, noseburn, pricklypear, and various annual plants. Spots of deep soils like those in the loamy-prairie range site occur in crevices and pockets in the limestone rock. These soils support taller grasses, mainly big bluestem, Indian grass, switchgrass and little bluestem.

This site produces about 3,000 pounds (air-dry weight) of forage per acre in a year of favorable rainfall, and about 1,000 pounds per acre in a year of unfavorable rainfall.

Sandy-Savanna Range Site (F)

This range site is usually included in the upland-forest range site described in this report. It consists of the Stephenville soil in Darnell-Stephenville fine sandy loams, with 2 to 6 percent slopes. The acreage is small, and the soil is moderately deep and is well drained.

The original vegetation consisted of tall grasses and scattered trees. Little bluestem, big bluestem, Indian grass, switchgrass, and wildrye are dominant decreasers. The trees are mainly post oak, blackjack oak, and hickory. They thicken if the site is overgrazed continually. Heath aster, goldenrod, purpletop, purple lovegrass, tall dropseed, and Scribner panicum are the principal increasers. Broomsedge bluestem, splitbeard bluestem, ironweed, marestail, coralberry, and persimmon are the chief invaders. Brush control is usually necessary to speed recovery of the better grasses.

This site produces about 5,000 pounds of herbage (air-dry weight) per acre in a year of favorable rainfall, and about 3,000 pounds per acre in a year of unfavorable rainfall.

Upland Forest (F)

This site consists of Darnell stony sandy loam (5 to 30 percent slopes) and the Darnell soil in Darnell-Stephenville fine sandy loams (2 to 6 percent slopes). The soils are typically shallow or very shallow and stony. The loamy surface layer takes in moisture readily, but the soils are so shallow that space for moisture storage and root development is limited.

The climax vegetation on this site consists of a stand of post oak, blackjack oak, and hickory, and a ground cover of tall grasses. The most abundant decreaser grass on the site is little bluestem. Other decreaser plants include big bluestem, Indian grass, switchgrass, slender lespedeza, Stuve's lespedeza, Illinois tickclover, and hairy sunflowers.

On much of this site, the stands of trees have gradually thickened as a result of heavy grazing and annual burning in past years. Some areas have a dense stand of brush, which limits production severely. The principal increaser grasses are purpletop, Scribner panicum, tall dropseed, and purple lovegrass. The dominant invader plants are broomsedge bluestem, splitbeard bluestem, ironweed, marestail, ragweed, and coralberry. Brush control followed by deferment of grazing is usually necessary for improvement of areas that are in fair or poor condition.

This site produces about 3,800 pounds of herbage (air-dry) per acre in a year of favorable rainfall, and about 1,800 pounds per acre in a year of unfavorable rainfall.

Cross-Timbers Range Site (C)

The soils of this site vary from shallow to deep. The deeper sandy soils take moisture readily but the shallower soils are mostly stony and limited in moisture-holding capacity. The shallow soils oftentimes have underlying sandstone beds that limit moisture penetration and root growth. Runoff is often excessive.

In its pristine condition the vegetation consisted of grass understory and thin stands of oak and hickory. Principal grasses are big bluestem, little bluestem, switchgrass, and Indian grass. Overstory species include black oak, post oak, blackjack oak, hickory, elm, and other trees.

Grazing and frequent burning have resulted in a decrease in the amount of grass and an increase in the scrubby oaks. Brush control is normally the first step in grazing management. Careful grazing is necessary because shallow soils of this site erode severely if the ground cover is destroyed.

Deeper soils may be better managed for forest products than grasses.

ENCLOSURE 4: SPECIES LIST OF SCIENTIFIC AND COMMON NAMES OF GRAMINOIDS, FORBS, AND WOODY AND SHRUB-LIKE PLANTS.

Graminoids

Agropyron smithii	western wheatgrass
Andropogon gerardi	big bluestem
Andropogon saccharoides	silver bluestem
Andropogon scoparius	little bluestem
Andropogon ternarius	splitbeard bluestem
Andropogon virginicus	broomsedge (yellowsedge) bluestem
Aristida longiseta	perennial (red) threeawn
Aristida oligantha	annual (prairie) threeawn
Bouteloua curtipendula	side-oats grama
Bouteloua gracilis	blue grama
Bouteloua hirsuta	hairy grama
Bromus spp.	bromes
Bromus japonicus	Japanese brome
Buchloe dactyloides	buffalo grass
Carex spp.	sedges
Cenchrus pauciflorus	mat sandbur
Chloris verticillata	tumble windmillgrass
Cynodon dactylon	bermudagrass
Echinochloa crusgalli	barnyardgrass
Elymus canadensis	Canada wildrye
Elymus virginicus	Virginia wildrye
Eragrostis spectabilis	purple lovegrass
Leptoloma cognatum	tall witchgrass
Muhlenbergia racemosa	green muhly
Panicum scribnerianum	Scribner panicum
Panicum virgatum	switchgrass
Paspalum floridanum	Florida paspalum
Poa pratensis	Kentucky bluegrass
Schedonnardus paniculatus	tumblegrass
Setaria geniculata	knotroot bristlegrass
Setaria lutesceus	yellow bristlegrass
Sorghastrum nutans	Indian grass
Spartina pectinata	prairie cordgrass
Sporobolus asper	tall dropseed
Sporobolus asper hookeri	meadow tall dropseed
Sporobolus cryptandrus	sand dropseed
Sporobolus vaginiflorus	annual dropseed
Tridens flavus	purpletop
Tridens stricta	longspike tridens
Tripsacrum dactyloides	eastern gamagrass

Forbs

Ambrosia bidentata	lanceleaf ragweed
Ambrosia psilostachya	western ragweed
Ambrosia trifida	giant ragweed
Aster ericoides	health aster
Baptisia spp.	wildindigo
Cardnus nutans	musk thistle
Croton texensis	Texas croton
Desmanthus illinoensis	Illinois bundleflower (tickclover)
Echinacea angustifolia	blacksamson echinacea
Galium aparine	catchweed bedstraw
Gutierrezia dracunculoides	annual broomweed
Gutierrezia sarothrae	broom snakeweed
Helenium tenuifolium	bitter sneezeweed
Helianthus grosserratus	sawtooth sunflower
Helianthus hirsutus	hairy sunflower
Helianthus mollis	ashy sunflower
Helianthus salicifolius	willowleaf sunflower
Hippuris vulgaris	marestail
Lespedeza capitata	roundhead lespedeza
Lespedeza procumbens	trailing lespedeza
Lespedeza sturvei	Sturve's lespedeza
Lespedeza virginica	slender lespedeza
Liatris punctata	dotted gayfeather
Lupinus spp.	lupines
Medigo sativa	wild alfalfa
Parthenium spp.	parthenium
Petalostemum multiflorus	roundhead prairieclover
Petalostemum oligophyllus	white prairieclover
Petalostemum purpureum	purple prairieclover
Plantanus occidentalis	annual plantain
Psoralea tenuiflora	slimflowered scurfpea (wild alfalfa)
Rudbeckia hirta	blackeyed susan
Salvia azuria	azure sage
Salvia pitcheri	Pitcher's sage
Sanicula spp.	snakeroot
Silphium integrifolium	wholeleaf rosinweed
Silphium laciniatum	compassplant
Solidago missouriensis	Missouri goldenrod
Solidago ridgida	stiff goldenrod
Tephrosia virginiana	Virginia tephrosia
Tragia nepetaefolia	noseburn

Verbena stricta	Woolly verbena
Vernonia baldwini	Baldwin ironweed

Woody and Shrub-like Plants

Acacia angustissima	prairie acacia
Acer rubrum	red maple
Acer saccharinum	silver maple
Amorpha canescens	leadplant amorpha
Artemisia spp.	sagebrush, sagewort
Carya cordiformus	bitternut hickory
Carya illinoensis	pecan
Ceanothus americanus	jerseytea ceanothus
Ceanothus ovatus	inland ceanothus
Celtis occidentalis	common hackberry
Cronus asperifolia	roughleaf dogwood
Crataegus spp.	hawthorn
Dalea spp.	indigo bush
Diospyros spp.	persimmon
Fraxinus pennsylvanica	red ash
Fraxinus pennsylvanica lanceolata	green ash
Juglans nigra	eastern black walnut
Juniperus virginiana	eastern redcedar
Opuntia vulgaris	common pricklypear
Platanus occidentalis	sycamore (American plaintree)
Populus deltoides	cottonwood (eastern poplar)
Quercus borealis	northern red oak
Quercus macrocarpa	bur oak
Quercus marilandica	blackjack oak
Quercus muhlenbergi	chinkapin oak
Quercus stellata	post oak
Quercus velutina	black oak
Rhus aromatica	fragrant sumac
Rhus glabra	smooth sumac
Rubus spp.	blackberry
Salix spp.	willows
Schrankia uncinata	catclaw sensitivebrier
Symphoricarpos orbiculatus	Indiancurrant coralberry (buckbrush)
Ulmus americana	American elm
Ulmus pumila	Siberian (Chinese) elm

F: BIOLOGICAL INVENTORIES: WILDLIFE ECOLOGY

BIOLOGICAL INVENTORIES: WILDLIFE ECOLOGY
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
Drs. Paul G. Risser and Loren G. Hill
Oklahoma Biological Survey
University of Oklahoma

CONTENTS

LIST OF TABLES AND FIGURES

INTRODUCTION

The purpose of this report is to evaluate the fauna and the wildlife habitats of three tallgrass-prairie study areas in Kansas and Oklahoma.

Study Area	Approximate Size	Counties
Wabaunsee (Wa)	60,000 acres	Wabaunsee (Kansas)
Chase (Ch)	100,000 acres	Chase, Greenwood, Butler (Kansas)
Osage (Os)	93,000 acres	Osage (Oklahoma), Cowley (Kansas) Chautauqua (Kansas)

The dominant vegetation in each area is grass, in particular tall grasses such as little bluestem *(Andropogon scoparius)*, big bluestem *(A. gerardi)*, Indian grass *(Sorghastrum nutans)*, and switchgrass *(Panicum virgatum)*. Although portions of the three areas are now grazed by domestic livestock and there have been some related shifts in species composition, the areas can still be classified as native tallgrass prairie. The topography is rolling and each of the areas has at least one major stream and numerous smaller tributaries. Lowland forests are found along the drainages, and small ponds occur throughout the areas.

The central portion of the Wabaunsee study area encompasses the Illinois Creek watershed, which drains north into the west branch of Mill Creek. Cultivated sites are limited to scattered areas along Illinois Creek and bottomlands along the west and south branches of Mill Creek.

The topography of the Chase study area is less rolling, but is still differentiated topographically, especially along Verdigris River and Thurman Creek. There are numerous small clear-flowing streams and three major reservoirs.

The Osage study area is just west of the prairie/forest ecotone and, as a result, areas of upland forest are usually referred to as cross timbers. The site does have some flat terrain, but primarily encompasses rolling hills. The northern boundary includes the Caney River and Rock Creek. Buck Creek and Sand Creek are also contained in the study area. Cultivation occurs in the bottomlands, especially along Rock Creek.

For the purposes of habitat evaluation, 14 basic habitat types have been defined (table 1). These classification types are labeled, using both vegetational and topographic terms, but the scale of differentiation is based on the distribution and habitat preferences of the various faunal elements. Figures 1, 2, and 3 are maps showing the wildlife habitats in the three study areas.

Following are descriptions of the fauna (fishes, reptiles and amphibians, birds, and mammals) of the three proposed areas.

Table 1. Wildlife habitats.

Moderately-to-lightly grazed grasslands (1)	These grasslands retain essentially all of the native grass species, although under moderately grazed conditions the decreasers may be significantly reduced. Grasslands that are mowed periodically for prairie hay are also included in this category.
Heavily grazed grasslands (2)	These grasslands are characterized by decreasers and invaders. The forage production is definitely decreased. Forbs may make up a significant portion of the biomass.
Claypan grasslands (3)	These are mostly upland sites that have a soil high in clay. This operates effectively as a shallow soil resulting in a species composition of mid and short grasses.
Successional grasslands (4)	These are grasslands recovering from heavy grazing or other disturbances. Species composition includes some native grasses, as well as successional species such as *Aristida,* etc.
Improved pastures (5)	These are pastures that have been planted either to bermuda grass *(Cynodon* spp.) or other grasses, (e.g. *Festuca* spp.).
Croplands (6)	These are agricultural lands that are currently planted to a crop.
Rocky outcrops (7)	These are shallow soils, usually rocky in nature, that occur primarily on the ridgetops.
Cross timbers (8)	These forests have an open canopy, consist primarily of oaks *(Quercus* spp.), and are found on coarse-textured soils.
Upland forests (9)	These forests consist primarily of oaks and hickories *(Carya* spp.), occur in upland areas, and have a closed canopy.
Riparian forests (10)	These forests occur along streams and in wet habitats. They are characterized by riparian species such as willows *(Salix),* cottonwoods *(Populus),* and ash *(Fraxinus).*
Main streams (11)	Lotic waters: mainstreams and large tributaries.
Small streams (12)	Lotic waters: smaller streams.
Ponds and lakes (13)	Lentic waters: ponds and lakes.
Other (14)	

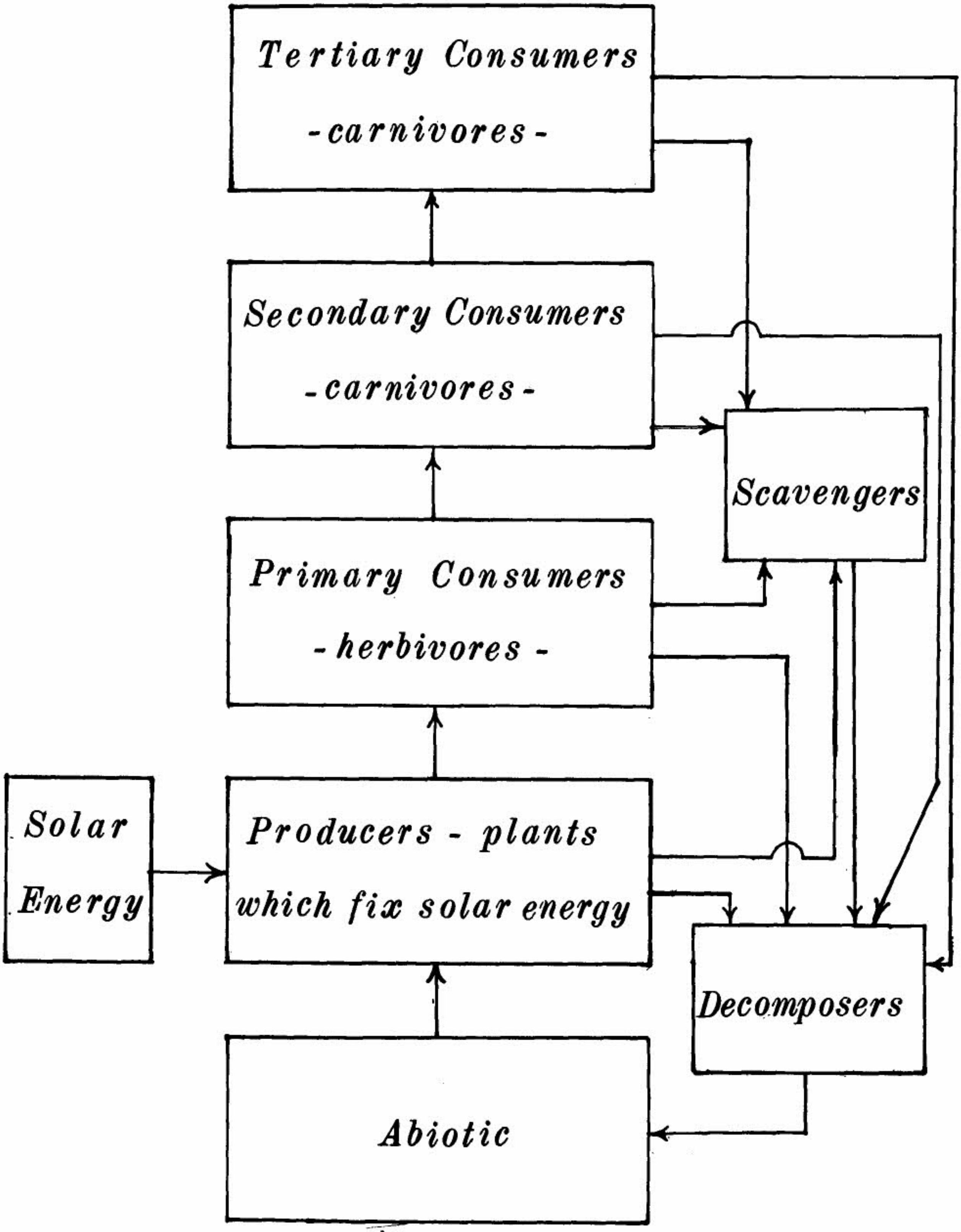
THE PRAIRIE ECOSYSTEM

ECOLOGICAL INTERRELATIONSHIPS

On the prairie, as in any ecosystem, the distribution, density, and abundance of organisms is largely determined by the energy relationships existing among them and between them and their environment. Ultimately all energy comes from the sun and some of this solar energy is captured by green plants through the process of photosynthesis. A portion of the captured energy is utilized in the metabolic processes of plants, but more is stored as structural material in the plants. It is this stored energy that is available to the animal community. Animals capture energy by feeding on plants or other animals. Like plants, they store some of this energy within their bodies; thus, it can be passed on in turn to other organisms.

In the following discussion, energy is thought of as food energy, and the energy transfer between plants and animals or between animals occurs by feeding. Within an organism, energy may be stored, or utilized in metabolism. By simplifying the picture greatly, the representative organisms can be assigned to various classes or levels depending on their primary food source (see figure 1). These levels, based on nutrition, are called trophic levels. Plants that fix the sun's energy comprise the first trophic level, and are called producers. Organisms (primarily animals) that feed on plants are in the second trophic level, and are termed the primary consumers or herbivores. Carnivores (animals that eat other animals) comprise the highest two levels. Those that feed on herbivores, the secondary consumers, belong to the third trophic level, and those that eat other carnivores are tertiary consumers and belong to the fourth trophic level. Obviously, many animals ingest a wide variety of foods, and do not fit into one distinct trophic level. A fox eats herbivores and carnivores indiscriminately and is thus both a secondary and a tertiary consumer. A sparrow often eats insects as well as seeds, and is thus both a secondary and primary consumer. Opossums *(Didelphis marsupialis)* and crows *(Corvus brachyrhynchos)* eat nearly anything they find; therefore they belong at different times to trophic levels 2, 3, and 4. However, most animal species can be assigned to one or another trophic level, making the concept general enough to be useful in explaining energy flow through the ecosystem. An additional trophic level, not strictly in line with the others, includes the animals and plants that feed on dead material – the decomposers and scavengers. These animals return the organic wastes and remains of all other trophic levels to the earth so that the raw materials may be reused by the other organisms of the ecosystem. Figure 1 shows a diagrammatic sketch of the trophic levels and energy flows.

Figure 1. Biological energy flow diagram.



On the prairie, the principal producers are grasses such as the bluestems *(Andropogon)*, Indian grass *(Sorghastrum)*, and switchgrass *(Panicum)*. Oaks *(Quercus)*, hickories *(Carya)*, willows *(Salix)*, poplars *(Populus)*, and ashes *(Fraxinus)* are the major producers in the forested areas, and algae and phytoplankton assume this role in aquatic areas.

The producers are consumed by many animals from various classes. Insects, especially grasshoppers, caterpillars, and various beetles, ingest huge amounts of plant matter. With the exception of the box turtles *(Terrapene)*, no prairie amphibian or reptile feeds on plants to any significant extent. Relatively few birds belong to this level. Among them are sparrows, finches, quail, and hummingbirds. Herbivorous mammals are common on the prairie. Rabbits and mice may feed on the seeds, shoots, and roots of small plants, as do the ground squirrels *(Citellus)* and pocket gophers *(Geomys)*. The larger grazing herbivores have primarily been replaced by domestic cattle. On undisturbed prairie, wapiti *(Cervis)*, bison *(Bison)*, and pronghorn *(Antelocapra)* would occupy this level.

At the secondary consumer level, large numbers of animals enter the picture. Predatory insects such as dragonflies, many wasps, and some beetles devour other insects. Frogs *(Rana, Acris)* and toads *(Bufo)* consume large numbers of insects. Most lizards (e.g. *Crotaphytus, Eumeces)* and smaller snakes *(Diadophis, Thamnophis)* are insectivorous. A great many birds belong in this level. Flycatchers, swallows, thrushes, wrens, warblers, and woodpeckers are but a few of the families represented. Many smaller mammals such as bats, shrews, and some rodents (e.g. *Onychomys)* prey heavily upon insects.

Vertebrate herbivores are also preyed upon, with predators of various sizes feeding on appropriately sized prey. The small mammalian and avian herbivores are eaten by a variety of snakes *(Pituophis, Elaphe, Coluber)*. Predatory birds (hawks, owls, shrikes, and herons) and predatory mammals such as coyote *(Canis latrans)*, bobcat *(Lynx rufus)*, skunks *(Mephites)*, and weasels *(Mustela)*, feed at this level. On undisturbed prairie, the large mammalian herbivores would be preyed upon by the mountain lion *(Felis concolor)* and gray wolf *(Canis lupus)*.

No animals are classed solely as tertiary consumers. Most predators listed as secondary consumers take on a tertiary consumer function at times, eating other secondary consumers. Hawks feeding on snakes are a good example. There are also a number of animals termed omnivores that occupy all levels from primary to tertiary consumer. The collared lizard *(Crotaphytus collaris)*, common crow, opossum, and coyote are examples.

Scavengers serve an important function in the prairie ecosystem, aiding the decomposers' job of removal of dead organisms. The turkey vulture *(Cathartes aura)*,

bald eagle *(Haliaeetus leucocephalus)*, crow, and coyote fill this role on a large scale, while insects such as scavenger beetles *(Silphidae)*, rove beetles *(Staphylinidae)*, and blowflies *(Calliphoridae)* act on a smaller scale. The decomposers are primarily fungi and bacteria.

Aquatic habitats have trophic patterns similar to the terrestrial environment and follow the same principles of energy transfer. Algae and phytoplankton are the major producers with significant amounts of energy also entering from the terrestrial community – runoff during rainfall and objects falling into the water. Primary consumers of algae include stoneroller minnows *(Campostoma anomalum)*, red shiners *(Notropis leutrensis)*, and the larvae of most fish, amphibians, and aquatic insects.

Fish such as the shiners *(Notropis)*, sunfish *(Lepomis)*, and darters *(Etheostoma)* feed heavily on insect larvae. The spotted bass *(Micropterus)*, water snakes *(Natrix)*, and various turtles *(Chelydra, Pseudemys)* feed on larger insect larvae and fish. As in the terrestrial ecosystem, many predators feed on each other, thus becoming tertiary consumers. Birds such as herons, ducks, and shorebirds, and mammals such as river otters *(Lutra canadensis)* and raccoons *(Procyon lotor)* comprise the higher trophic levels of the aquatic habitats. Scavengers in the aquatic habitat include some fish, such as suckers *(Moxostoma)*, as well as turtles *(Kinosternon, Chelydra)* and some insects.

The prairie ecosystem has an extremely complex web of energy relationships, and all organisms comprising the ecosystem are necessary for its continued survival as a functioning unit. Because some members of the highest trophic level are no longer present in any of the study areas and are not likely to be successfully reintroduced, man will have to assume their role in the ecosystem. Thus, it is essential that management practices be based on a thorough understanding of the ecosystem and of its representative parts.

FISHES

This section lists the abundant fishes known to occur within three study areas. Field collections were made at 18 locations within the three areas during March and April 1975. However, only the portions of streams easily accessible from roads were sampled, and much of this report is based upon a survey of the literature concerning the fishes of the area. Primary sources of information were Cross (1954), Metcalf (1959), Cross (1967), and Conservation Committee, Kansas Academy of Science (1973). Additional distributional information was from Blair (1959), Minckley and Cross (1959), Metcalf (1966), Cross and Braasch (1968), and Miller and Robison (1973). Some details on life history are from Pflieger (1971).

Description of the Areas

All three study areas include grasslands of the Flint Hills region of Kansas; the Osage area also extends into the Osage savanna and mixed-grass plains districts of northern Oklahoma. Detailed habitat analyses of the areas are currently being compiled. A list of the habitat types found within the areas appears in table 1. Most streams within the study areas consist of relatively small creeks or tributaries of an intermittent nature. Principal larger streams include:

Wabaunsee: Mill Creek, tributary of the Kansas River

Chase: South fork of the Cottonwood River of the Neosho River System

Osage: Caney River, tributary of the Arkansas River System, including main stream and some moderately sized tributaries

Characteristics of the Reported Ichthyofauna

WABAUNSEE

Reported Species	Possible Additional Species	Rare or Endangered Species	Noteworthy Species
36	10	2	9

Mill Creek contains a rather unique assemblage of upland fishes, some of which are more characteristic of the Ozark streams to the east. Several species in Mill Creek are scarce, limited in distribution, or declining in numbers in Kansas.

Percina maculata (blackside darter) is endangered in Kansas, and is now known only in Mill Creek (Conservation Committee, Kansas Academy of Science 1973). *Moxostoma erythrurum* (golden redhorse) in the Kansas River basin is known only from Mill Creek (Cross 1967). *Moxostoma macrolepidotum* (northern redhorse) in the Kansas River basin has only been collected in Mill Creek in recent years (Cross 1967). *Nocomis biguttatus* (hornyhead chub) has declined in northern and western Kansas, and is now considered an endangered species in the state (Conservation Committee, Kansas Academy of Science 1973); in the Kansas River basin, it has been recently collected only from Mill Creek (Metcalf 1966). *Notropis rubellus* (rosyfaced shiner) in the Kansas River basin is almost confined to Mill Creek, and may be en route to extirpation in the basin (Metcalf 1966). *Noturus exilis* (slender madtom) is known from only a few streams of the Kansas River basin, but is common in Mill Creek (Cross 1967). *Minytrema melanops* (spotted sucker), *Ictalurus punctatus* (channel catfish), and *Stizostedion canadense* (sauger) have not been reported in streams of the

Wabaunsee area since 1915, and were probably never common or abundant (Cross 1967). Channel catfish are likely present in artificial impoundments, due to stocking.

CHASE

Reported Species	Possible Additional Species	Rare or Endangered Species	Noteworthy Species
26	16	3	8

Included in the Chase study area are the headwaters of tributaries of the Neosho River system. Some Ozarkian species are found in the Chase study area that are not present in the Wabaunsee study area, but the ichthyofauna is less diverse.

Hybopsis amblops (bigeyed chub), now considered an extirpated species in Kansas, was last collected near the Chase study area. Two other species that may occur in the Chase study area are considered endangered: *Notorus placidus* (Neosho madtom) is considered endangered nationally (Conservation Commission of the Kansas Academy of Science 1973), and *Nocomis asper* (redspot chub) is on the committee's endangered list for the state. There are reasonable doubts, however, that the Neosho madtom ascends such small tributaries of the Neosho River as are found in the Chase area.

Notropis pilsbryi (duskystripe shiner) and *Etheostoma flabellare* (fantailed darter) both occur as relict populations disjunct from populations in the Ozark Mountains (Cross 1967). *Micropterus dolomieui* (smallmouth bass), channel catfish, and *Stizostedion canadense* (sauger) have not been taken in the Chase area since 1915 (Cross 1967).

OSAGE

Reported Species	Possible Additional Species	Rare or Endangered Species	Noteworthy Species
50	3	0	1

The larger number of species present in the Osage study area may be attributed to the presence of mainstream Caney River within the watershed, which affords habitat for species more typical of larger streams, such as *Ictiobus bubalus* (smallmouthed buffalo), *Carpiodes carpio* (river carpsucker), *Lepisosteus osseus* (longnosed gar), *Lepisosteus oculatus* (spotted gar), and *Notropis atherinoides* (emerald shiner). The number of reported species may be somewhat exaggerated, however, because distributional records in the Oklahoma portion of the study area are based primarily on a Miller and Robison report (1973), which included generalized range maps, but not point locations where collections had been made. If waters in the Osage study area were included in a species range, as indicated in Miller and Robison, that species is listed in table 2 – unless habitat requirements obviously rule out the possibility of its occurrence.

Notropis ortenburgeri (Kiamichi shiner) probably occurs within the Oklahoma portion of the Osage study area. This population is disjunct from its larger known populations in southeastern Oklahoma (Miller and Robison 1973).

Rare, Endangered, Extirpated, or Noteworthy Species

None of the fish species known to occur within the three study areas are listed as rare or endangered nationally (USDI 1973). The following list includes those species found within or near the study areas that are considered rare, endangered, or extirpated according to the Conservation Committee, Kansas Academy of Science (1973). Criteria utilized by the committee to establish categories are also listed:

Endangered species:

A form with a relict distribution whose existence and prospects for survival throughout its range are in immediate jeopardy because its habitat is threatened with destruction or deterioration, or because of over-exploitation, disease, predation, or competition.

Notorus placidus (Neosho madtom)

Listing is expected in the next federal register of endangered species. Range includes lower main stream of Cottonwood River. Species might also occur in some of the tributaries of the south fork of Cottonwood River within the Chase study area.

Species endangered in Kansas but not nationally:

Neither endangered nor rare in their total range, but populations and range within Kansas have declined appreciably in the last 100 years.

Nocomis asper (redspot chub)

Species was found in the south fork of Cottonwood River in Chase County through early 1950, but not after. It may occur within the Chase study area.

Nocomis biguttatus (hornyhead chub)

Species is still found in Mill Creek, Wabaunsee County, within the Wabaunsee study area.

Percina maculata (blackside darter)

Species is known in Kansas only in Mill Creek near Alma, Wabaunsee County, within the Wabaunsee study area.

Extirpated species:

Species which have been extirpated from Kansas in the last 100 years (not necessarily extinct outside of Kansas).

Hybopsis amblops (bigeyed chub)

The last record of this species in Kansas is of uncertain date – thought to be in the 1930s, in the south fork of Cottonwood River near Matfield Green, Chase County, just north of the Chase study area.

Noteworthy species:

In addition to the above species, the committee listed three species that, although not presently rare or endangered, require special attention to ensure their continued survival in Kansas. Two of these species are found in or near the present study areas:

Notropis topeka (Topeka shiner)
Species is rare except in tributaries of the Kansas River that drain the limestone uplands of the Flint Hills, and is found in the Wabaunsee and Chase study areas.

Percina phoxocephala (slenderheaded darter)
Species is locally common in the larger tributaries of the Arkansas and Osage River systems, eastern Kansas, and has been reported near the Chase study area and within the Osage study area in Oklahoma.

Potential Reintroductions

Hybopsis amblops (bigeyed chub) is the only species considered recently extirpated within or near an area of the study. The bigeyed chub might be reestablished in its former habitat in the south fork of Cottonwood River, including tributaries of this stream that lie within the Chase study area. This species is generally associated with gravel or clean sand, and is intolerent of silt. It most often occupies clear water where currents are not swift (Cross 1967).

Three other species might be considered for reintroduction, but literature does not clearly indicate whether or not they have ever occurred in or near the study areas. The listing of the following species should not be interpreted as a recommendation for introduction:

Ichthyomyozon castaneus (chestnut lamprey) was reported prior to 1915 in the vicinities of the Wabaunsee and Chase study areas. This species is more common in large streams, but spawns in smaller tributaries, and is parasitic upon other fish species (Cross 1967).

Notropis heterolepis (blacknosed shiner) may have occurred in eastern Kansas, possibly in the Chase or Wabaunsee study areas. It requires clear, cool, weedy water (Cross 1967).

Noturus miurus (brindled madtom) infrequently enters southern Kansas. It may have occurred in the Caney River of the Osage study area. It prefers quiet pools of large clear streams, often in association with organic detritus (Cross 1967).

Table 2. Account of fishes by study area.

KEY

ABUNDANCE

1 =	Common:	Present in large numbers throughout much of the study area
2 =	Occasional:	Found in small numbers in much of the area or possibly in large numbers in limited habitats
3 =	Rare:	When present, only in very small numbers
4 =	Possible:	Known to occur in the general geographic region, but status in the study area unknown
5 =	Extirpated	
0 =	Absent	

HABITAT

Habitat categories and their criteria are shown in table 1. Where necessary, appropriate microhabitat preferences are provided in the "Comments" section.

Species	Wa	Ch	Os	Habitat	Comments
Family Lepisosteidae (gar)					
Lepisosteus oculatus Spotted gar	0	0	2	11, 13	Generally intolerant of turbidity
Lepisosteus osseus Longnosed gar	4	4	2	11	Prefer base of riffles, eddies, pools
Lepisosteus platostomus Shortnosed gar	0	4	2	11	Most common in main streams of large rivers
Family Clupeidae (herring and shad)					
Dorosoma cepedianum Gizzard shad	2	4	2	13	Prefers deep calm water; filter feeds on microorganisms
Family Cyprinidae (minnow and carp)					
Cyprinus carpio Carp	2	4	2	11, 13	High fecundity, spawns on vegetation in shallow water
Carassius auratus Goldfish	4	0	0	13	Prefers quiet water with much vegetation; introduced as a bait fish and by aquarium escapes
Notemigonus crysoleucas Golden shiner	2	0	2	13	A frequent bait-bucket introduction
Semotilus atromaculatus Creek chub	2	2	2	12	A hardy pioneering fish most common in clear headwaters
Phoxinus erythrogaster Southern red-bellied dace	1	0	0	12	Common only near outflow of springs

Species	Wa	Ch	Os	Habitat	Comments
Nocomis asper Redspot chub	0	3	0	12	Occupies clear streams over silt-free bottoms
Nocomis biguttatus Hornyhead chub	3	3	0	12	Found in clear, permanent, rocky creeks; declining abundance in past century
Hybopsis amblops Bigeyed chub	0	4	0	12	Only one record from Kansas, now believed extirpated
Hybognathus placitus Plains minnow	4	0	2	11	Most common in streams of sand bottom and shallow braided flow
Phenacobius mirabilis Sucker-mouthed minnow	2	2	3	12	Prefers tributaries of moderate gradient and sand or gravel bottoms
Campostoma anomalum Stoneroller	1	1	1	12	Common in small upland streams with gravel bottoms
Notropis atherinoides Emerald shiner	0	0	2	12	Most common in large sandy rivers; rarely in tributaries
Notropis boops Bigeyed shiner	0	0	1	11, 12	Requires clear upland streams or large clear rivers
Notropis buchanani Ghost shiner	4	0	3	11	Common at confluence of tributaries with main rivers and along gravel bars in midstream
Notropis camurus Blunt-faced shiner	0	2	2	12	Prefers moderately fast clear streams of small and medium size
Notropis cornutus Northern common shiner	1	0	0	12	Most common in small to moderately sized streams with clear cool water over gravel or rubble

Species	Wa	Ch	Os	Habitat	Comments
Notropis lutrensis Red shiner	1	1	1	11, 12	Thrives in extreme habitats; adapts well to water level fluctuations
Notropis ortenburgeri Kiamichi shiner	0	0	4	12	In small to moderately sized clear upland streams; disjunct population in Osage study area of Oklahoma
Notropis pilsbryi Dusky-striped shiner	0	1	0	12	Requires clear flowing water over silt-free rubble or gravel; disjunct from main Ozarkian population
Notropis rubellus Rosy-faced shiner	1	3	2	12	In upland streams having steep gradients and limestone substrate
Notropis stamineus Sand shiner	3	3	3	11, 12	Two subspecies; one prefers sandy rivers, the other prefers upland tributaries
Notropis topeka Topeka shiner	3	3	0	12	Now rare except in upland limestone tributaries; most common in pools of intermittent streams
Notropis umbratilis Red-finned shiner	3	2	1	12	Abundant in upland limestone creeks having high gradient and rocky riffles; usually occupies quiet water
Notropis volucellus Mimic shiner	0	4	3	11, 12	Occupies larger upland streams having rocky bottoms
Pimephales notatus Bluntnosed minnow	1	1	1	12	Found in small streams with permanent flow over rocky bottoms
Pimephales promelas Fatheaded minnow	3	3	3	12	Greatest abundance in pools of small intermittent creeks with mud or clay bottoms; popular bait minnow
Pimephales tenellus Slim minnow	0	4	3	12	Prefers clear flowing water over rock substrate

Species	Wa	Ch	Os	Habitat	Comments
Pimephales vigilax Bullheaded minnow	0	0	2	11	Most common in backwaters or pools with silt or sand bottoms
Family Catostomidae (suckers)					
Ictiobus bubalus Small-mouthed buffalo	0	0	1	11	Common in pools, oxbow lakes, or backwaters; sometimes on swift riffles
Ictiobus niger Black buffalo	0	0	4	11	Often in deep, fast riffles where channel narrows; prefers strong currents
Carpiodes carpio River carpsucker	4	0	2	11, 12	Prefers backwaters or calm pools where sediments accumulate
Minytrema melanops Spotted sucker	3	3	3	11, 13	Occasionally found in small creeks over firm bottoms; reported in major rivers and impoundments
Moxostoma erythrurum Golden redhorse	2	1	2	12	Most common in main stream of small creeks draining limestone soils and having high gradients and permanent flow
Moxostoma duquesnei Black redhorse	0	0	4	12	Prefers clear moderately sized tributaries with high gradients and rocky bottoms
Moxostoma macrolepidotum Northern redhorse	2	4	0	12	Occurs in deep riffles; Mill Creek contains the only population known in the Kansas River basin
Catostomus commersonnii White sucker	2	0	0	11, 12, 13	Distribution probably declining; habitat variable

Species	Wa	Ch	Os	Habitat	Comments
Family Ictaluridae (catfish)					
Ictalurus melas Black bullhead	3	0	2	12	Most common in pools of small streams and waters of soft bottoms and high turbidity; not abundant in clear water
Ictalurus natalis Yellow bullhead	4	3	4	11, 12	Most common in clear rocky tributaries having permanent flow
Ictalurus punctatus Channel catfish	4	4	4	11, 12, 13	Common in many streams in Kansas; stocked in many ponds
Pylodictus olivaris Flathead catfish	4	4	4	11, 13	Occupies deep holes in larger rivers; highly piscivorous
Noturus exilis Slender madtom	1	0	0	12	Prefers gravel riffles of small streams with continual flow
Noturus flavus Stonecat	3	4	0	11	Most commonly over rocky bottoms of large streams
Noturus nocturnus Freckled madtom	0	0	4	12	Found in riffles or in debris in streams with moderate to low gradients
Noturus placidus Neosho madtom	0	4	0	11	Unique to Neosho River, generally restricted to main stream, associated with gravel bars in fast current
Family Cyprinodontidae (killifishes and pupfishes)					
Fundulus notatus Blackstriped topminnow	0	3	3	12	Prefers clear small streams with rocky or muddy bottoms

Species	Wa	Ch	Os	Habitat	Comments
Fundulus kansae Plains killifish	0	0	3	11	Most likely in waters at least moderately saline
Family Poeciliidae (livebearers)					
Gambusia affinis Mosquito fish	0	0	2	12, 13	A livebearer; feeds on insect larvae near surface; prefers pools and backwaters
Family Serranidae (sea basses)					
Roccus chrysops White bass	0	0	1	11, 13	Rare prior to impoundment construction; highly mobile; swims in large schools
Family Centrarchidae (sunfishes)					
Micropterus dolomieui Smallmouth bass	0	4	0	12	Associated with cool clear waters of upland streams
Micropterus punctulatus Spotted bass	0	1	4	11, 12	Mostly in small clear streams draining limestone uplands
Micropterus salmoides Largemouth bass	4	4	3	11, 12, 13	Does well only in clear water; abundance has increased in impoundments
Chaenobryttus gulosus Warmouth	4	0	0	13	Primarily found in ponds; often in turbid water with soft bottoms and dense weed beds
Lepomis cyanellus Green sunfish	2	1	1	12	Principal habitat consists of small muddy creeks but nearly ubiquitous in Kansas waters
Lepomis humilis Orange-spotted sunfish	3	3	1	12, 13	Widespread in Kansas waters; best adapted to sandy streams but occurs in a wide variety of habitat types

Species	Wa	Ch	Os	Habitat	Comments
Lepomis macrochirus Bluegill	2	3	1	11, 12, 13	Much stocked in ponds
Lepomis megalotis Longear sunfish	1	1	1	12	Inhabits upland streams with clear water and clean bottoms
Lepomis microlophus Redear sunfish	0	0	3	11, 12, 13	Stocked in many ponds; has escaped to many Oklahoma streams
Promoxis annularis White crappie	2	0	1	11, 13	One of the commonest fish in Kansas; impoundment and stocking have increased abundance
Promoxis nigromaculatus Black crappie	3	0	3	13	May not be native to Kansas; present as a result of stocking
Family Percidae (perches)					
Stizostedion canadense Sauger	4	4	0	11	A northern species; may occur seasonally in Kansas in large freeflowing streams
Perca flavescens Yellow perch	4	0	0	13	Reported in a reservoir near Wabaunsee study area; prefers clear lakes with vegetation
Percina caprodes Logperch	3	3	3	12	Common only in clear permanent limestone streams; most often in deep riffles over gravel or rubble
Percina copelandi Channel darter	0	4	4	12	Principally in pools with rocky substrate and at least moderate current
Percina maculata Black-sided darter	3	0	0	12	Extremely rare in Kansas waters; known only in Mill Creek (Wabaunsee area) in recent years

Species	Wa	Ch	Os	Habitat	Comments
Percina phoxocephala Slenderheaded darter	0	4	3	11	Usual habitat is in swift shallow water over gravel or bedrock in larger streams
Etheostoma flabellare Fantailed darter	0	2	0	12	Occupies shallow riffles in small clear tributaries; Chase populations disjunct from principal range
Etheostoma nigrum Johnny darter	2	0	0	12	Inhabits small spring-fed streams with high gradients; usually found over firm bottoms where current is slight; distribution has declined
Etheostoma spectabile Orangethroat darter	1	1	1	12	Most widespread of Kansas darters; occurs mainly in shallow riffles with bottoms of gravel or sand
Etheostoma whipplei Redfinned darter	0	0	3	12	Found in medium-sized clear streams with low-to-moderate gradients and sand or gravel bottoms
Family Sciaenidae (Drums)					
Aplodinotus grunniens Freshwater drum	4	0	3	11, 13	Common in deeper pools of rivers and in impoundments; feeds on bottom fauna, including molluscs
Family Atherinidae (silversides)					
Labidesthes sicculus Brook silverside	0	0	1	12	Prefers rocky-bottomed pools in clear streams with considerable current

REPTILES AND AMPHIBIANS

The herpetofauna of each study area is composed of a mixture of eastern and western species, many of which have their distributional boundaries in this region of the Midwest. In all, Kansas and Oklahoma contain 133 species of herpetofauna (81 reptiles and 52 amphibians), of which 63 species of reptiles and 25 species of amphibians are common to both states. References consulted in the preparation of this section includes Breukelman and Clarke (1951); Clarke, Breukelman, and Andrews (1958); Gier (1967); Smith (1956); Webb (1970); and others herein cited.

As shown below, the numbers of both reptiles and amphibians increase from the Wabaunsee study area in northern Kansas to the Osage study area in southern Kansas and northern Oklahoma. Differences in habitat distribution (for instance, the Osage study area has considerably more forest than either of the other study areas) also contribute to the differences in species numbers and abundance.

		Reported Species	Possible Additional Species	Rare or Endangered Species	Noteworthy Species
Wabaunsee	Amphibians	10	3	0	1
	Reptiles	38	10	1	3
Chase	Amphibians	13	2	0	1
	Reptiles	38	13	1	2
Osage	Amphibians	15	2	0	1
	Reptiles	45	6	1	3

Rare and Endangered Species

Platt (1973) has catalogued the rare, endangered, and extirpated species of Kansas, and this section is primarily based on his listing. No Kansas reptiles or amphibians are listed as endangered, and the only nationally rare species present in Kansas – the grotto salamander *(Typhlotriton spelaeus)* – is not known in any of the study areas.

Several species of reptiles and amphibians are considered to be rare in Kansas, and Platt (1973) has recommended setting aside natural areas, monitoring pesticide use throughout Kansas, and other measures to ensure their survival within the state. Ranges for three such species fall within or near the study areas under consideration. These are described below.

The crayfish frog *(Rana areolata)* is an inhabitant of moist lowland meadows, floodplains, and grasslands. It lives in crayfish burrows and probably in other small

burrows. It is quite secretive and is rarely seen except during the breeding season. It has been recorded near all three study areas. Collins (1974) considers this species threatened due to habitat destruction. The construction of dams, dikes, and levees appears to be causing water-table fluctuations and the loss of moist meadows and floodplains required by the animal. It is recommended that if one of three study areas is preserved, such habitats be set aside and protected from drainage to secure the status of this species.

The alligator snapping turtle *(Macroclemys temmincki)* inhabits large mud-bottomed rivers and canals. It is very rare in Kansas, with only two specimens recorded in the state. Medium-to-large rivers pass through all three study areas; those in the Chase and Osage study areas are part of the same water system from which the two known specimens were taken. If such turtles are found in any of the study areas, preservation of the habitat and control of pesticides will be required to ensure species survival.

The smooth green snake *(Opheodrys vernalis)* has only been recorded in three counties in northeastern Kansas, two of which (Geary and Riley counties) border the Wabaunsee study area. This animal inhabits the moist grassland along the forest edge. Because it is an insectivore, the discontinuance of pesticide use and the preservation of habitat would probably ensure its survival.

Noteworthy Species

Four species of reptiles and amphibians found in the study areas are worthy of special mention. The bullfrog *(Rana catesbeiana)* is widely used and valued as food, being a source of "frog legs." The three venomous snakes of the areas – the copperhead, timber rattlesnake, and massasauga – are of interest because of their potential danger to human life and wildlife.

The bullfrog is a common inhabitant of almost every permanent body of water, and is found along the edges of creeks, rivers, lakes, streams, and farm ponds, usually at night. Depending on the size of the body of water and the food availability, bullfrog populations can reach quite high densities. Fitch (1958) reports that the ½-acre pond on the University of Kansas Natural History Reservation at times supports hundreds of adults and subadults. Although individuals do establish and defend territories, there is considerable reshuffling of individuals, and home ranges are ephemeral.

Collins (1974) calls the bullfrog an opportunistic predator, which eats anything it can swallow – from aquatic beetles and other arthropods, small fish, turtles, and snakes to full-grown swallows. The bullfrog, in turn, is eaten by almost any predatory bird, mammal, or reptile that can subdue it. The bullfrog has some economic importance as a human food item and both Kansas and Oklahoma require fishing licenses for its capture.

The bullfrog would be affected by prairie park establishment only if a large number of the "cattle tank" ponds were eliminated. Increasing the natural predator populations might reduce its numbers.

The copperhead *(Agkistrodon contortrix)* has been recorded in the vicinity of all three study areas. Fitch (1960) characterizes its habitat requirements as "ground that is shaded by a leaf canopy and blanketed with leaf litter from deciduous trees. Preferably this substrate should be wet or at least damp during the time that the snakes are active." In general, the rocky forested hillsides and the riparian forests of the study areas would provide a suitable habitat for this snake.

Copperhead populations can reach high densities. Fitch (1960) gives an approximate 3.6 snakes/acre for the University of Kansas Natural History Reservation, with individual snakes having home ranges of 8.5 to 24.4 acres. Whether or not any of the study areas could support such densities is not known.

The copperhead feeds primarily on small rodents, with other small mammals, birds, small reptiles, amphibians, and insects filling out the diet. As such, it is often attracted to agricultural areas where rodents, some birds, and insects abound. The copperhead is eaten by king snakes, hawks, moles, and opossums.

Copperheads account for 34 percent of all reported venomous snakebites in the United States. Kansas and Oklahoma experience 24.3 and 61 bites respectively per million inhabitants per year. The fatality rate is only about 0.01 percent and the bite is not usually considered as deadly (all from Parrish and Carr 1967).

Unless large parts of any of the study areas were converted to forest, the establishment of a Prairie National Park should not cause any increase in copperhead density or distribution within the area.

The timber rattlesnake *(Crotalus horridus)* is found in much the same habitat as the copperhead – heavily vegetated rocky outcrops on forested hillsides – except that the moisture requirement is not as stringent. Details of population density and home range are not available for this snake, although Fitch (1958) mentions that it moves greater distances than does the copperhead. In some parts of its range, the timber rattlesnake can be among the most numerous of snakes (Klauber 1972), although this is not likely in any of the study areas due to the paucity of suitable habitat.

The timber rattlesnake feeds primarily on small mammals, although birds and their eggs, frogs, and other lower vertebrates are also eaten. Many of the larger predatory mammals (wolves, coyotes, and badgers), predatory birds, and king snakes feed on the rattlesnake. Other animals such as the deer and antelope have been known to kill rattlesnakes although they do not eat them.

Rattlesnakes as a whole account for about 55 percent of all venomous snakebites in the U.S. Of these, an estimated 3 percent prove fatal. Figures for the timber rattlesnake alone are not available, although its bite must be considered potentially lethal.

As with the copperhead, only extensive conversion to forest would increase timber rattlesnake populations in any of the study areas.

The massasauga rattlesnake *(Sistrurus catenatus)* is found in a wide range of habitats from open arid prairie to open wetlands. Details of population density are not available for this species. Green and Oliver (1965) state that it is the most frequently encountered snake on the road at night near Ft. Worth, Texas.

The massasauga's food includes large numbers of lizards, frogs, small snakes, and small rodents. It is eaten by numerous predatory mammals and birds, as well as by other snakes.

Statistics of massasauga bites are not available. Klauber (1972) and Minton and Minton (1969) state that although bites may occur frequently, they are rarely fatal.

Data is lacking, but it is possible that prairie park establishment, along with the cessation of rattlesnake destruction by humans, would result in increased numbers of this snake in any of the areas

Extirpated Species and Potential Reintroductions

According to Platt (1973), there are no herpetofaunal species that have been unquestionably extirpated from Kansas, and there are therefore no possible reintroductions.

Table 3. Account of herpetofauna by study area.

KEY

ABUNDANCE

1 = Common: Present in large numbers throughout much of the study area

2 = Occasional: Found in small numbers in much of the area or possibly in large numbers in limited habitats

3 = Rare: When present, only in very small numbers

4 = Possible: Known to occur in the general geographic region, but status in the study area unknown

5 = Extirpated

0 = Absent

HABITAT

Habitat categories and their criteria are shown in table 1. Occurrence and abundance of reptiles and amphibians is often not as dependent on the gross habitat composition as it is on the presence or absence of specific features of that habitat (termed microhabitat). Where appropriate, these microhabitat requirements plus other notes are mentioned in the "Comments" column.

Species	Wa	Ch	Os	Habitat	Comments
CLASS AMPHIBIA Subclass Urodela (salamanders)					
Ambystoma texanum Smallmouthed salamander	2	2	2	10, 12, 13	Found in damp regions near ponds, under cover; may be present in large numbers at certain times of the year
Ambystoma tigrinum Tiger salamander	2	2	2	1, 4-6, 10-13	Ubiquitous; during and after a rain may be found almost anywhere
Necturus maculosus Mudpuppy	3	3	4	11-13	Found primarily in rivers and creeks, rarely in ponds
Subclass Anura (frogs and toads)					
Scaphiopus bombifrons Plains spadefoot toad	4	4	4	1-5	Prefers loose sandy soil; often appears in tremendous numbers during or immediately after a rainstorm; may be difficult to find otherwise
Scaphiopus hurteri Hurter's spadefoot toad	0	0	2	9, 10	Often appears in tremendous numbers during or immediately after a rainstorm; may be difficult to find otherwise
Bufo cognatus Great Plains toad	4	1	1	1-5	Burrows in the soil; often found under cover
Bufo americanus American toad	4	2	2	9, 10	Found in wet forested areas under cover
Bufo woodhousei Rocky Mountain toad	2	2	2	1-5, 8, 9	
Acris crepitans Blanchard's cricket frog	1	1	1	11-13	Found along periphery of almost any body of water

Species	Wa	Ch	Os	Habitat	Comments
Pseudacris clarki Spotted chorus frog	0	3	2	1-5	
Pseudacris triseriata Western chorus frog	1	1	1	1-5, 10-13	Found in almost any damp area
Pseudacris streckeri Strecker's chorus frog	0	0	2	10-13	
Hyla chrysoscelis Cope's grey treefrog	3	3	3	10	Found along woodland bodies of water
Rana areolata Crayfish frog	0	4	3	5, 14	Found in meadowland in crayfish burrows
Rana catesbeiana Bullfrog	2	2	2	11-13	Found along shores where there is slow-moving or still water
Rana pipiens Leopard frog	1	1	1	1-6, 11-13	Found in grasslands or forest near any water
Gastrophyryne olivacea Great Plains narrow-mouthed frog	2	2	2	7, 8	Usually found under rocks
CLASS REPTILIA Subclass Chelonia (turtles)					
Sternotherus odoratus Stinkpot turtle	0	4	3	11, 13	Found in mud-bottomed waters
Kinosternon flavescens Yellow-bellied mud turtle	3	3	3	11-13	Found in mud-bottomed waters
Macroclemys temminckii Alligator snapping turtle	0	3	3	11	Lives in large mud-bottomed rivers; only two specimens known in Kansas

Species	Wa	Ch	Os	Habitat	Comments
Chelydra serpentina Common snapping turtle	2	2	2	11-13	Prefers mud-bottomed waters
Terrapene carolina Three-toed box turtle	4	4	2	4-6, 8	Found in open woodland
Terrapene ornata Ornate box turtle	1	1	1	1-6	
Graptemys geographica Map turtle	4	4	4	11, 13	
Graptemys pseudogeographica False map turtle	4	4	4	11-13	
Chrysemys picta Painted turtle	2	2	2	11-13	Found in slow-moving or still waters
Chrysemys floridana Missouri slider	4	4	4	12, 13	Found in slow-moving or still waters
Pseudemys scripta elegans Red-eared slider	2	2	2	11, 13	Prefers muddy-bottomed bodies of water
Trionyx muticus Smooth soft-shelled turtle	4	4	3	11, 12	Found in sand or mud-bottomed streams and rivers
Trionyx spiniferus Spiny soft-shelled turtle	2	2	2	11-13	
Subclass Lacertilia (lizards)					
Holbrookia maculata Earless lizard	4	2	4	2, 3	Found on sandy soil with sparse vegetation

Species	Wa	Ch	Os	Habitat	Comments
Crotaphytus collaris Collared lizard	2	1	1	1-3, 7, 8	Found under or around rocks in any open terrain
Sceloporus undulatus Eastern fence lizard	4	4	2	9, 10	Found on trees, fallen timber, fences
Phrynosoma cornutum Texas horned lizard	2	2	2	1-3	Found in dry areas with sparse vegetation
Lygosoma laterale Brown skink	2	2	2	9, 10	Found among leaves and other debris
Eumeces anthracinus Coal skink	0	0	4	9, 10	Usually found among rocks or other debris
Eumeces fasciatus Five-lined skink	1	2	2	8, 9	Prefers a moist environment
Eumeces obsoletus Great Plains skink	1	1	1	1-5, 8	
Eumeces septentrionalis Southern prairie skink	2	4	4	1-5	
Cnemidophorus sexlineatus Six-lined racerunner	2	2	2	1-3	Found in dry sandy areas with low vegetation
Ophisaurus attenuatus Slender glass lizard	3	3	3	1-5, 8-10	Found in moist areas
Subclass Serpentes (snakes)					
Carphophis vermis Worm snake	2	2	2	9, 10	Found under logs and rocks
Diadophis punctatus Prairie ringneck snake	1	1	1	1-5, 7-10	Found under debris; abundant only in spring

Species	Wa	Ch	Os	Habitat	Comments
Heterodon platyrhinos Eastern hognosed snake	3	3	3	5, 6, 8, 9	Prefers loose sandy areas
Opheodrys aestivus Rough green snake	3	3	3	8, 9, 10-13	Found in bushes or on the ground
Opheodrys vernalis Smooth green snake	4	0	0	4, 5, 10	Usually found on the ground
Coluber constrictor Yellow-bellied racer	1	1	1	1-8	
Masticophis flagellum Eastern coach whip snake	0	2	2	1-8	
Elaphe guttata Great Plains rat snake	2	2	2	5, 7-9	Found in areas with rocks for cover
Elaphe obsoleta Black rat snake	1	1	1	8-10	Often climbs trees; enters barns and the areas of grain storage
Pituophis melanoleucus Bullsnake	1	1	1	1-8	Often found around barns and areas of grain storage
Lampropeltis calligaster Prairie kingsnake	2	3	3	1-8	Found in open rocky areas
Lampropeltis getulus Speckled kingsnake	2	2	2	6-10	Found in moist woods, marshes, fields, and on rocky hillsides
Lampropeltis triangulum Red milk snake	2	2	2	7-10	Found under rocks and logs in or near wooded areas
Sonora episcopa Plains ground snake	0	4	3	1-4, 7, 8	Found under flat rocks and debris
Tantilla gracilis Flat-headed snake	3	2	2	1-4, 7, 8	Found under flat rocks and debris

Species	Wa	Ch	Os	Habitat	Comments
Virginia striatula Rough earth snake	0	0	3	7-9	Found under debris
Tantilla nigriceps Plain black-headed snake	4	4	3	1-4, 7, 8	Found on hillsides under stones
Natrix erythogaster Blotched water snake	1	1	1	11-13	Found along shores of almost any body of water
Natrix grahami Graham's water snake	3	3	3	11-13	Found along shores of almost any body of water; feeds primarily on crayfish
Natrix rhombifera Diamond-back water snake	2	4	1	11-13	Found along shores of almost any body of water
Natrix sipedon Common water snake	1	1	1	11-13	Found along shores of almost any body of water
Storeria deKayi DeKay's snake	2	2	2	10	Found under debris in most moist situations
Thamnophis sirtalis Red-sided garter snake	1	1	2	4-6, 8, 10-13	Usually found in any moist situation
Thamnophis radix Western Plains garter snake	2	2	0		
Thamnophis proximus Western ribbon snake	2	1	1	11-14	Found in swamps

Species	Wa	Ch	Os	Habitat	Comments
Tropidoclonion lineatum Central lined snake	2	2	2	1-4, 7	Found under debris
Agkistrodon contortrix Northern copperhead	2	3	1	7-10	Found on rocky forested hillsides; dangerously venomous
Sistrurus catenatus Western massasauga	3	2	3		Found in arid open prairie, rocky hillsides, and open wetlands; dangerously venomous
Crotalus horridus Timber rattlesnake	3	4	3	9, 10	Found along heavily vegetated rocky outcrops on partially forested hillsides; dangerously venomous

BIRDS

Since the study areas are so close to the ecotone between the tallgrass prairie and eastern deciduous forest, the avifauna is extremely varied. Many eastern forms reach their western limits near the study areas, and many western forms also occur on the study areas. In addition, substantial numbers of waterfowl and shorebirds pass through during migration. Large concentrations of hawks and some eagles are winter residents in each area. Avifaunal species diversity in the three study areas is a result of habitat diversity and geographic positioning. The Osage study area appears to have more diverse habitats and hence more potential species than the others. Certain species (such as the common redpoll and snowy owl) occur in the Wabaunsee study area in winter more frequently than in the more southerly localities. Likewise, others (roadrunner, yellow-crowned night heron) are more common on the Osage study area in summer than within the other areas to the north.

All together, 383 bird species have been recorded in Kansas (Johnston 1965) and 394 in Oklahoma (Sutton 1974). Specific records for the study areas are extremely meager. However, records of bird sitings have been kept for the area around Emporia, Lyon County, Kansas, which is situated between the Wabaunsee and Chase study areas. Clarke, Breukelman, and Andrews (1958) listed 248 species actually recorded in Lyon County. Betts (1974) listed 130 species seen by the Kansas Ornithological Society in late April 1974, several of which were not included by Clarke et al. Additional winter records (111 species for the Flint Hills area in 1973, 107 in 1974) are provided by the winter bird counts (Ely 1974, Thompson 1975). The publications of Johnston (1964, 1965) form the basis of the data found in table 4 for the two Kansas study areas. The papers cited above provided much additional information for these study areas. Sutton's publications (1967, 1974) provided the information for the Osage study area.

Because birds are so mobile, an attempt was made to include all species that could potentially occur in the study areas. Many of these would, of course, be very rare, but all have been recorded in the general geographic vicinity (within 60 miles) of the study areas. Breeding status was evaluated in the same manner, and many of those listed as breeding species would be rather marginal. Thus, 302 species are tabulated of which 111 are represented as potential breeding species.

By study area these totals are:

STUDY AREA	SPECIES OCCURRING	SPECIES BREEDING
Wabaunsee	295	104
Chase	296	99
Osage	297	102

Rare and Endangered Species

The Conservation Committee of the Kansas Academy of Science (1974) published a list of rare, endangered, and threatened species of birds that occur in Kansas. The following annotated list is taken from that paper but modified to include only those species potentially occurring in the study areas. Although the Osage study area is mostly in Oklahoma, no additional species in any of the categories are present there.

Endangered species:

Falco peregrinus (Peregrine falcon)
Species occurs rarely during migration throughout the Flint Hills.

Grus americana (Whooping crane)
Since the total population of this species is only approximately 50, it is very rarely seen during migration. However, its migration route passes directly over the study areas.

Numenius borealis (Eskimo curlew)
Species has long been thought extinct. Since 1950 a few records exist for Galveston Island, Texas. Last record for Kansas was in 1891. Species' former migration route was through the Flint Hills (not included in table 4).

Threatened species (species so rare that they are very close to becoming endangered):

Haliaeetus leucocephalus alkansus (Bald eagle)
Unlike the other races of the bald eagle, the Alaskan race, which occurs in winter in Kansas, is only listed as threatened.

Falco mexicanus (Prairie falcon)
Species occurs as a rare transient and winter resident in the Flint Hills.

Speotyto cunicularia (Burrowing owl)
Species occurs as a rare transient on the Flint Hills.

Species endangered in Kansas but not nationally:
No species fall into this category.

Species threatened in Kansas but not nationally:
The species rare enough in Kansas to be placed in this category are too numerous to list here, and can be found in table 4.

Extirpated Species and Possible Reintroductions

No extant species are known to have been extirpated from the study areas.

Ecological Requirements of Selected Species

The following paragraphs discuss the ecological requirements of waterfowl, hawks, gallinaceous birds, and owls in the study areas. These groups are of special interest and in the case of waterfowl and gallinaceous birds may be economically important.

Waterfowl: With the creation of large numbers of farm ponds and reservoirs, an increasingly large number of waterfowl utilize these water areas in the Flint Hills during migration; some winter at these sites. Waterfowl have increased in numbers in the past decades (Sutton 1967), and are likely to continue to increase as long as grain fields and impoundments remain. Requirements vary from group to group. Geese use grain fields for feeding and open water for roosting; the grain fields are particularly important for wintering birds. Dabbling ducks *(Anas, Aix)* use shallow waters for feeding and roosting; these ducks are often abundant and hunters take more of these than any others. Diving ducks and related species *(Aythya, Bucephala, Mergus,* etc.) frequent deeper waters where they can catch fish by diving, and are most common on the larger bodies of water, although certain species (e.g., A. *collaris)* prefer smaller farm ponds.

Hawks: Several species of hawks prey on the abundant rodent populations of the Flint Hills throughout the year. This area is an important wintering ground for rough-legged hawks *(Buteo lagopus)* because it provides the open grasslands preferred by the species (Schnell 1968). Golden eagles *(Aquila chrysaetos)* also utilize wide expanses of open country to find food in the winter, and roam throughout the Flint Hills during that season. Bald eagles *(Haliaeetus leucocephalus)* are present in significant numbers during the winter (five were seen during a field trip to the Osage study area in March 1975). Because these eagles primarily eat fish or are scavengers, they occur most commonly around ponds and lakes.

Pheasant, grouse, and quail: The ring-necked pheasant *(Phasianus colchicus)* is a species introduced into the United States from China. It has been successful only in northern portions of the U.S., and the southern limit of its range occurs in Kansas. Thus it is only found on the northern two study areas. Pheasant use grain fields for food, and prefer brushy areas for cover. For this reason they are not as common in the Chase study area as in Wabaunsee. The grouse family is represented by the greater prairie chicken *(Tympanuchus cupido).* Prairie chickens, like pheasant, are highly prized game birds. They require extensive tallgrass prairie, but do best when stands of oak woodland are within reasonable distance (30 miles) (Johnsgard 1973). They use the woodland for food (acorns) and shelter during the fall and winter. Like pheasant and quail, they use grain fields, when present. Quail, represented by the bobwhite *(Colinus virginianus),* prefer areas that exhibit a mixture of grassland, cropland, brushy area, and woodland (Johnsgard 1973). Thus, they are likely to be found in edge situations in the study areas. Where these four types of habitats are present (grassland and cropland, 50 to 80 percent), bobwhites usually do well.

Owls: Owls are plentiful in all three study areas. Several species are present, and their habitat requirements vary considerably. Great-horned owls *(Bubo virginianus)*, the most abundant, occur throughout the study areas, whereas barred owls *(Strix varia)* are found only in the lowland forests along the streams. Both of these owls hunt by night for rodents. Several other owls more typical of prairie habitats hunt during the daytime or at dawn and dusk. Among these are the burrowing owl *(Speotyto cunicularia)*, short-eared owl *(Asio flammeus)*,and snowy owl *(Nyctea scandiaca)*. All of these occur primarily in grasslands. The burrowing owl usually nests in prairie-dog towns, and occurs only as a transient in the study areas. The short-eared owl breeds in Kansas (Johnston 1964), and may potentially breed in the study area. Both the short-eared and snowy owls winter in these areas.

Other species: The many other species that occur in the study areas are outlined in table 4, and their habitat preferences are noted.

Table 4. Account of birds by study area.

KEY

OCCURRENCE

Seasonal occurrence — status

- PR = Permanent resident: Occurs throughout the year
- SR = Summer resident: Present only in summer
- WR = Winter resident: Present only in winter
- T = Transient: Occurs during spring and/or fall migration times

Abundance

- 1 = Common: Present in large numbers throughout much of the study area
- 2 = Occasional: Present in small numbers or possibly in large numbers in very limited habitats
- 3 = Rare: When present, only in very small numbers
- 4 = Possible: Known to occur in the general geographic region, but status on the study area unknown
- 5 = Extirpated
- 0 = Absent

BREEDING

Potential breeding species are denoted as summer residents (SR) or as permanent residents (PR) of a study area

HABITAT

Habitat categories and their criteria are shown in table 1. Where necessary, appropriate microhabitat preferences are provided in the "Comments" section. All thicket and brushy areas are assumed in this table to be represented as parts of habitats 8, 9, and 10.

A blank indicates insufficient information to determine status.

Species	Wa	Ch	Os	Habitat	Comments
Family Gaviidae (loons)					
Gavia immer Common loon	T 4	T 3	T 4	13	Found on large lakes and rivers
Gavia stellata Red-throated loon	T 4	T 4	T 4	13	Found on large lakes and rivers; accidental
Family Podicipedidae (grebes)					
Podiceps grisegena Red-necked grebe	T 4	T 4	T 4	13	Found on large lakes and rivers; accidental
Podiceps auritus Horned grebe	T 3	T 2	T 3	13	
Podiceps caspicus Eared grebe	T 4	T 3	T 4	13	Visitant from west
Aechmophorus occidentalis Western grebe	T 4	T 4	T 4	13	Accidental visitant from west
Podilymbus podiceps Pied-billed grebe	T-SR 1	T-SR 1	T-SR 1	13	Abundance in summer very much reduced
Family Pelicanidae (pelicans)					
Pelecanus erythrorhynchos White pelican	T 3	T 2	T 3	13	Found on large lakes and rivers
Family Phalacrocoracidae (cormorants)					
Phalacrocorax auritis Double-crested cormorant	T 3	T 2	T 3	13	Found on large lakes and rivers

Species	Wa	Ch	Os	Habitat	Comments
Family Ardeidae (herons, egrets, bitterns)					
Ardea herodias Great blue heron	T-SR 1	T-SR 1	T-SR 1	11, 13	
Butorides virescens Green heron	T-SR 1	T-SR 1	T-SR 1	11-13	Often found near streams
Florida caerulea Little blue heron	T 4	T 4	T 3	13	
Bubulcus ibis Cattle egret	T 4	T 3	T 3	1-5, 13	Often found with cattle
Casmerodius albus Great egret	T 4	T 3	T 3	11, 13	Found primarily near larger lakes and rivers
Egretta thula Snowy egret	T 4	T 3	T 3	11-13	
Hydranassa tricolor Louisiana heron	0	T 4	T 4	11, 13	Accidental visitant from south
Nycticorax nycticorax Black-crowned night heron	T 3	T 3	T 2	11, 13	Often found in cattail marsh
Nyctanassa violacea Yellow-crowned night heron	T 3	T 3	T 3	11, 13	
Ixobrychus exilis Least bittern	T-SR 3	T-SR 3	T-SR 3	11, 13	Present but difficult to find
Botaurus lentiginosus American bittern	T-SR 3	T-SR 2	T-SR 2	11, 13	Prefers cattail marshes

Species	Wa	Ch	Os	Habitat	Comments
Family Threskiornithidae (ibises, spoonbills)					
Plegadis chihi White-faced ibis	T 4	T 4	T 4	11, 13	Accidental vagrant from west
Family Anatidae (swans, geese, ducks,					
Olor columbianus Whistling swan	T 3	T 3	T 3	13	Found principally on larger lakes
Branta canadensis Canada goose	T 2	T 1	T 1	5, 6, 13,	Often feeds in grain fields
Anser albifrons White-fronted goose	T 2	T 1	T 2	5, 6, 13	Often feeds in grain fields
Chen caerulescens Snow goose	T 2	T 1	T 2	5, 6, 13	Often feeds in grain fields
Anas platyrhynchos Mallard	PR 2	PR 2	PR 2	13	
Anas rubripes Black duck	T-WR 3	T-WR 3	T-WR 3	13	Visitant from east
Anas strepera Gadwall	T 2	T 2	T 2	13	
Anas acuta Pintail	T 2	T 1	T 2	13	
Anas crecca Green-winged teal	T 2	T 2	T 2	13	
Anas discors Blue-winged teal	T-SR 1, 2	T-SR 1, 2	T-SR 1, 2	13	Much less abundant in summer

Species	Wa	Ch	Os	Habitat	Comments
Anas cyanoptera Cinnamon teal	T 4	T 3	T 3	13	
Anas clypeata Northern shoveler	T 2	T 2	T 2	13	
Anas americana American wigeon	T 2	T 2	T 2	13	
Aix sponsa Wood duck	T-SR 2, 3	T 2	T-SR 2, 3	13	Utilizes cavities in trees for nesting
Aythya americana Redhead	T-WR 2, 3	T-WR 2, 3	T-WR 2, 3	13	Less abundant in winter
Aythya collaris Ring-necked duck	T-WR 2, 3	T-WR 2, 3	T-WR 2, 3	13	Less abundant in winter; frequents small ponds
Aythya valisineria Canvasback	T-WR 2, 3	T-WR 2, 3	T-WR 2, 3	13	Less abundant in winter
Aythya affinis Lesser scaup	T 2	T 1	T-WR 1, 3	13	
Bucephala clangula Common goldeneye	T 3	T 3	T 3	13	
Bucephala albeola Bufflehead	T 2	T 2	T 2	13	
Clangula hyemalis Old squaw	T 4	T 3	T 4	13	Prefers large lakes and rivers
Melanitta deglandi White-winged scoter	T 4	T 3	T 4	13	Prefers large lakes and rivers

Species	Wa	Ch	Os	Habitat	Comments
Melanitta perspicillata Surf scoter	T 4	T 4	T 4	13	Prefers large lakes and rivers; accidental
Oxyura jamaicensis Ruddy duck	T-WR 2	T-WR 2	T-WR 2	13	
Lophodytes cucullatus Hooded merganser	T 3	T 3	T 3	13	Prefers small ponds or open marshes
Mergus merganser Common merganser	T 2	T 1	T 2	13	May occur in huge flocks
Mergus serrator Red-breasted merganser	T 3	T 3	T 3	13	Prefers larger lakes and rivers
Family Cathartidae (American vultures)					
Cathartes aura Turkey vulture	T-SR 1	T-SR 1	T-SR 1	1-10	Scavengers for food in all habitats
Coragyps atratus Black vulture	0	0	T 4	1-4, 8	Accidental visitant from south
Family Accipitridae (hawks, kites, harriers, eagles)					
Ictinia misisippiensis Mississippi kite	T-SR 3	T-SR 3	T-SR 2	10	
Accipiter gentilis Goshawk	T 3	T 3	T 3	1-10	Occurs mainly in late fall and winter
Accipiter striatus Sharp-shinned hawk	T-WR 2	T-WR 2	T-WR 2	8-10	Seen over prairie in migration

Species	Wa	Ch	Os	Habitat	Comments
Accipiter cooperi Cooper's hawk	PR 2	PR 2	PR 2	8-10	Seen over prairie in migration
Buteo jamaicensis Red-tailed hawk	PR 1	PR 1	PR 1	1-10	
Buteo lineatus Red-shouldered hawk	T-SR 3	T 3	T-SR 3	10	Less abundant in summer
Buteo platypterus Broad-winged hawk	T-SR 3	T 3	T-SR 3	10	Less abundant in summer
Buteo swainsoni Swainson's hawk	T-SR 2	T-SR 1	T-SR 1	1-6	
Buteo lagopus Rough-legged hawk	T-WR 1	T-WR 1	T-WR 1	1-8	
Buteo regalis Ferruginous hawk	T-WR 3	T-WR 3	T-WR 3	1-8	Visitant from west
Aquila chrysaetos Golden eagle	T 3	T-WR 3	T-WR 3	1-10	
Haliaeetus leucocephalus Bald eagle	T 3	T-WR 2	T-WR 2	1-10, 13	Found most commonly near water
Circus cyaneus Marsh hawk	T-WR 1	T-WR 1	T-WR 1	1-10	Found flying low over marsh and prairie
Family Pandionidae (ospreys)					
Pandion haliaetus Osprey	T 3	T 3	T 3	13	Prefers large lakes and rivers

Species	Wa	Ch	Os	Habitat	Comments
Family Falconidae (falcons)					
Falco mexicanus Prairie falcon	T-WR 3	T-WR 3	T-WR 3	1-6	Visitant from west
Falco peregrinus Peregrine falcon	T 3	T 3	T 3	1-10	
Falco columbarius Merlin	T 3	T 3	T 3	1-8	
Falco sparverius American kestrel	PR 1	PR 1	PR 1	1-8	
Family Tetraonidae (grouse, ptarmigans, prairie chickens)					
Tympanuchus cupido Greater prairie chicken	PR 1	PR 1	PR 1	1, 2, 8	Utilizes cropland
Family Phasianidae (quails, partridges, pheasants)					
Colinus virginianus Bobwhite	PR 1	PR 1	PR 1	8, 9	Utilizes cropland and thicket areas
Phasianus colchicus Ring-necked pheasant	PR 2	PR 2	0	2-6, 8	Found primarily in thicket areas at prairie edge
Family Meleagrididae (turkeys)					
Meleagris gallopavo Turkey	0	0	PR 2	10	Probably restocked populations

Species	Wa	Ch	Os	Habitat	Comments
Family Gruidae (cranes)					
Grus americana Whooping crane	T 3	T 3	T 3	1, 2, 13	Seen primarily overhead on migration
Grus canadensis Sandhill crane	T 3	T 3	T 3	1, 2, 13	
Family Rallidae (rails, gallinules, coots, soras)					
Rallus elegans King rail	T 3	T 3	T 3	13	Prefers marshes
Rallus limicola Virginia rail	T-SR 2	T-SR 2	T-SR 2	13	Prefers marshes
Porzana carolina Sora	T-SR 2	T-SR 2	T-SR 2	13	Prefers marshes
Laterallus jamaicensis Black rail	T 4	T 4	T 4	13	Prefers marshes; extremely difficult to find
Porphyrula martinica Purple gallinule	T 4	T 3	0	13	Vagrant from south and east
Gallinula chloropus Common gallinule	T-SR 3	T-SR 3	T-SR 3	13	Prefers marshes
Fulica americana American coot	T 1	T 1	T 1	13	
Family Charadriidae (plovers, turnstones, surfbirds)					
Charadrius semipalmatus Semipalmated plover	T 3	T 3	T 3	6, 11, 13	Prefers mud flats

Species	Wa	Ch	Os	Habitat	Comments
Charadrius melodus Piping plover	T 3	T 3	T 3	6, 11, 13	Prefers mud flats
Charadrius alexandrinus Snowy plover	T 4	T 4	T 3	6, 11, 13	Found primarily on saline flats
Charadrius vociferus Killdeer	T-SR 1	T-SR 1	T-SR 1	5, 6, 11, 13	
Pluvialis dominica American golden plover	T 3	T 3	T 3	5, 6, 11, 13	Often found in plowed fields
Pluvialis squatarola Black-bellied plover	T 3	T 3	T 3	5, 6, 11, 13	Prefers mud flats

Family Scolopacidae (snipe, sandpipers, woodcocks, others)

Species	Wa	Ch	Os	Habitat	Comments
Philohela minor American woodcock	T 3	T 3	T 3	10	Prefers wooded swamps
Capella gallinago Common snipe	T 2	T 2	T-WR 2	6, 11, 13	
Numenius americanus Long-billed curlew	T 3	T 3	T 3	1, 2, 5, 6	Found on prairie
Numenius phaeopus Whimbrel	T 3	T 3	T 3	6, 11, 13	Prefers mud flats
Bartramia longicauda Upland sandpiper	T-SR 1	T-SR 1	T-SR 1	1, 2, 5, 6	Found on prairie

Species	Wa	Ch	Os	Habitat	Comments
Actitis macularia Spotted sandpiper	T-SR 1, 2	T-SR 1, 2	T-SR 1, 2	11-13	Found at water's edge
Tringa solitaria Solitary sandpiper	T 2	T 2	T 2	11-13	Found at water's edge
Tringa melanoleucus Greater yellowlegs	T 1	T 1	T 1	5, 6, 13	
Tringa flavipes Lesser yellowlegs	T 2	T 2	T 2	5, 6, 13	
Catoptrophorus semipalmatus Willet	T 3	T 3	T 3	6, 13	Prefers marsh
Calidris melanotos Pectoral sandpiper	T 1	T 1	T 1	5, 6, 13	Prefers mud flats
Calidris fuscicollis White-rumped sandpiper	T 3	T 3	T 3	6, 13	Prefers mud flats
Calidris bairdii Baird's sandpiper	T 1	T 1	T 1	5, 6, 13	Prefers mud flats
Calidris minutilla Least sandpiper	T 2	T 2	T 2	5, 6, 13	Prefers mud flats
Calidris alpina Dunlin	T 3	T 3	T 3	6, 13	Prefers mud flats
Calidris pusilla Semipalmated sandpiper	T 2	T 2	T 2	5, 6, 13	Prefers mud flats
Calidris mauri Western sandpiper	T 3	T 3	T 3	5, 6, 13	Prefers mud flats
Calidris alba Sanderling	T 3	T 3	T 3	6, 13	Prefers shorelines

Species	Wa		Ch		Os		Habitat	Comments
Limnodromus scolopaceus Long-billed dowitcher	T	3	T	3	T	3	5, 6, 13	Prefers mud flats
Micropalama himantopus Stilt sandpiper	T	3	T	3	T	3	6, 13	Prefers mud flats
Tryngites subruficollis Buff-breasted sandpiper	T	3	T	3	T	3	1-6, 13	Prefers shortgrass areas
Limosa fedoa Marbled godwit	T	3	T	3	T	3	6, 13	Prefers mud flats
Limosa haemastica Hudsonian godwit	T	3	T	3	T	3	6, 13	Prefers mud flats
Family Recurvirostridae (avocets, stilts)								
Recurvirostra americana American avocet	T	3	T	3	T	3	6, 13	Prefers mud flats
Family Phalaropodidae (phalaropes)								
Steganopus tricolor Wilson's phalarope	T	3	T	3	T	3	6, 13	Found on small ponds and marshes
Lobipes lobatus Northern phalarope	T	3	T	3	T	3	6, 13	Found on small ponds and marshes
Family Laridae (gulls, terns)								
Larus hyperboreus Glaucus gull	T	4	T	3	T	3	13	Prefers large lakes and rivers; vagrant from north
Larus argentatus Herring gull	T	3	T	3	T	3	13	Prefers large lakes and rivers

Species	Wa	Ch	Os	Habitat	Comments
Larus delawarensis Ring-billed gull	T-WR 3, 4	T-WR 2, 4	T-WR 2, 3	13	Prefers larger lakes and rivers
Larus pipican Franklin's gull	T 1	T 3	T 3	1-6, 13	Prefers prairie
Larus philadelphia Bonaparte's gull	T 3	T 3	T 3	13	Prefers lakes, rivers
Sterna forsteri Forster's tern	T 3	T 3	T 3	13	
Sterna albifrons Least tern	T 3	T 3	T 3	13	Frequents sandy areas
Hydroprogne caspia Caspian tern	T 3	T 3	T 3	13	Prefers large lakes and rivers
Chlidonias niger Black tern	T 3	T 3	T 3	13	Prefers marshes
Family Columbidae (pigeons, doves)					
Columba livia Rock dove	PR 1	PR 1	PR 1	5, 6	Found near habitation
Zenaida macroura Mourning dove	T-SR 1	T-SR 1	T-SR 1 WR 1, 3	5, 6, 8-10	Scarce in winter
Family Cuculidae (cuckoos, roadrunners, avis)					
Coccyzus americanus Yellow-billed cuckoo	T-SR 2	T-SR 3	T-SR 2	8-10	
Coccyzus erythropthalmus Black-billed cuckoo	T-SR 3	T-SR 3	T-SR 3	8-10	

Species	Wa	Ch	Os	Habitat	Comments
Geococcyx californianus Roadrunner	0	0	PR 3	8-9	Prefers thicket areas
Family Tytonidae (barn owls)					
Tyto alba Barn owl	PR 3	PR 3	PR 3	5, 6, 8	Found near habitation
Family Strigidae (all other owls)					
Otus asio Screech owl	PR 2	PR 3	PR 2	8-10	
Bubo virginianus Great-horned owl	PR 2	PR 2	PR 2	1-10	Found in nearly any habitat
Nyctea scandiaca Snowy owl	T 3	T 3	T 3	1-7	Visitant from north
Speotyto cunicularia Burrowing owl	T 3	T 3	T 3	1-7	Nests in prairie dog towns
Strix varia Barred owl	PR 2	PR 2	PR 2	10	
Asio otus Long-eared owl	T-WR 3	T-WR 3	T-WR 3	9, 10	
Asio flammeus Short-eared owl	PR 2	PR 2	T-WR 2	1-6	More common as a transient than in summer or winter
Family Caprimulgidae (goatsuckers, poorwills, nighthawks, others)					
Caprimulgus carolinensis Chuck-will's-widow	T-SR 3	T 3	T-SR 3	8-10	Crepuscular

Species	Wa	Ch	Os	Habitat	Comments
Caprimulgus vociferus Whip-poor-will	T 4	T 4	T 4	8-10	Visitant from east
Phalaenoptilus nuttalii Poor-will	T 3	T 3	T 4	8-10	Visitant from west
Chordeiles minor Common nighthawk	T-SR 1	T-SR 1	T-SR 1	1-6	Found near habitation; abundant in prairie
Family Apodidae (swifts)					
Chaetura pelagica Chimney swift	T-SR 1	T-SR 1	T-SR 1	5, 6, 9, 10	Found near habitation
Family Trochilidae (hummingbirds)					
Archilochus colubris Ruby-throated hummingbird	T-SR 2	T–SR 2	T-SR 2	8-10	
Family Alcedinidae (kingfishers)					
Megaceryle alcyon Belted kingfisher	PR 2	PR 2	PR 2	11-13	
Family Picidae (woodpeckers)					
Colaptes auratus Common flicker	PR 2	PR 2	PR 2	4-10	Found any place with trees
Dryocopus pileatus Pileated woodpecker	PR 3	PR 3	PR 2	10	Prefers habitat with large trees
Centurus carolinus Red-bellied woodpecker	PR 4	PR 2	PR 1	8-10	More common in south

Species	Wa	Ch	Os	Habitats	Comments
Melanerpes erythrocephalus Red-headed woodpecker	PR 2	PR 2	PR 2	8-10	
Sphyrapicus varius Yellow-bellied sapsucker	T-SR 3	T-SR 3	T 3	8-10	Much less abundant in summer
Dendrocopos villosus Hairy woodpecker	PR 3	PR 3	PR 3	8-10	
Dendrocopos pubescens Downy woodpecker	PR 1	PR 1	PR 1	8-10	
Family Tyrannidae (tyrant flycatchers)					
Tyrannus Tyrannus Eastern kingbird	T-SR 1	T-SR 1	T-SR 1	1-8	Often found in thicket areas
Tyrannus verticalis Western kingbird	T-SR 2	T-SR 2	T-SR 2	1-8	Often found in thicket areas
Muscivora forficata Scissor-tailed flycatcher	T-SR 2	T-SR 2	T-SR 1	1-8	Often found in thicket areas
Myiarchus crinitus Great crested flycatcher	T-SR 2	T-SR 2	T-SR 2	8-10	
Sayornis phoebe Eastern phoebe	T-SR 2	T-SR 2	T-SR 2	8-10	Often nests under bridges and eaves of homes
Sayornis saya Say's phoebe	T 4	T 3	T 4	1-8	Vagrant from west
Empidonax flaviventris Yellow-bellied flycatcher	T 4	T 4	T 4	8-10	Vagrant from northeast
Empidonax virescens Acadian flycatcher	T 4	T 4	T 4	8-10	Vagrant from south

Species	Wa	Ch	Os	Habitat	Comments
Empidonax trailii, E. alnorum Traill's flycatcher	T 3	T 3	T 3	8-10, 13	Often found in marshes
Empidonax minimus Least flycatcher	T 2	T 2	T 2	8-10	Prefers thicket
Contopus virens Eastern wood pewee	T-SR 1	T-SR 2	T-SR 2	8-10	
Nuttallornis borealis Olive-sided flycatcher	T 3	T 3	T 3	8-10	Often perches on high dead twigs
Family Alaudidae (larks)					
Eremophila alpestris Horned lark	PR 1	PR 1	PR 1	1-7	
Family Hirundinidae (swallows)					
Iridoprocne bicolor Tree swallow	T 3	T 3	T 3	12, 13	
Riparia riparia Bank swallow	T 3	T 3	T 3	12, 13	Nests colonially in sand banks
Stelgidopteryx ruficollis Rough-winged swallow	T-SR 2	T-SR 1	T-SR 2	1-7, 13	Nests singly in sand banks and mud banks
Hirundo rustica Barn swallow	T-SR 1, 2	T-SR 1, 2	T-SR 1, 2	1-7, 13	Often nests under bridges and culverts
Petrochelidon pyrrhonota Cliff swallow	T-SR 2	T-SR 2	T-SR 2	1-7, 13	Often nests under bridges
Progne subis Purple martin	T-SR 1	T-SR 2	T-SR 2	1-7, 13	Often found around habitation

Species	Wa	Ch	Os	Habitat	Comments
Family Corvidae (jays, magpies, crows)					
Cyanocitta cristata Blue jay	PR 1	PR 2	PR 1	8-10	Most common from late fall to spring
Corvus brachyrhynchos Common crow	PR 1	PR 1	PR 1	1-10	
Gymnorhinus cyanocephalus Pinon jay	T 4	T 4	T 4	8-10	Accidental visitant from west
Nucifraga columbiana Clark's nutcracker	T 4	T 4	T 4	8-10	Accidental visitant from west
Family Paridae (titmice, verdins, bushtits)					
Parus atricapillus Black-capped chickadee	PR 1	PR 1	0	8-10	
Parus carolinensis Carolina chickadee	0	0	PR 1	8-10	Replaces black-capped in south
Parus bicolor Tufted titmouse	PR 1	PR 2	PR 2	8-10	
Family Sittidae (nuthatches)					
Sitta carolinensis White-breasted nuthatch	PR 2	PR 2	PR 2	8-10	
Sitta canadensis Red-breasted nuthatch	T-WR 2	T-WR 2	T-WR 3	8-10	Prefers conifers
Sitta pygmaea Pygmy nuthatch	T 4	T 4	T 4	8-10	Vagrant from west

Species	Wa	Ch	Os	Habitat	Comments
Family Certhiidae (creepers)					
Certhis familiaris Brown creeper	T-WR 2	T-WR 3	T-WR 2	8-10	More common as a transient
Family Troglodytidae (wrens)					
Troglodytes aedon House wren	T-SR 1	T-SR 2	T-SR 1	8-10	Often found around habitation
Troglodytes troglodytes Winter wren	T 3	T 3	T 3	9, 10, 12	
Thryomanes bewickii Bewick's wren	PR 2	PR 2	PR 2	8-10	Often found around habitation
Thryothorus lucovicianus Carolina wren	PR 2	PR 2	PR 2	10	Much less common in winter
Telmatodytes palustris Long-billed marsh wren	T-SR 3	T-SR 3	T-SR 3	13	Prefers cattail marshes
Cistothorus platensis Short-billed marsh wren	T-SR 3	T-SR 3	T 3	14	Prefers shortgrass marshes
Salpinctes obsoletus Rock wren	T 4	T 4	T 3	7, 8	Vagrant from west; prefers rocky areas
Family Mimidae (mockingbirds, thrashers)					
Mimus polyglottos Mockingbird	PR 2	PR 2	PR 2	5, 6, 8	Usually found near habitation
Dumetella carolinensis Gray catbird	T-SR 2	T-SR 2	T-SR 2	10	

Species	Wa	Ch	Os	Habitat	Comments
Toxostoma rufum Brown thrasher	T-SR 1	T-SR 1	T-SR 1	8-10	
Family Turdidae (thrushes, bluebirds, solitaires)					
Turdus migratorius American robin	T-SR 1	T-SR 1	T-SR 1	1-10	Found near habitation or brushy areas
Hylocichla mustelina Wood thrush	T-SR 2	T-SR 3	T-SR 3	10	
Catharus guttatus Hermit thrush	T 3	T 3	T 3	8-10	Occurs in late fall and early spring
Catharus ustulatus Swainson's thrush	T 1	T 2	T 1	8-10	
Catharus minimus Gray-cheeked thrush	T 2	T 3	T 2	8-10	Migrates late in spring
Catharus fuscescens Veery	T 3	T 3	T 3	8-10	
Sialia sialis Eastern bluebird	PR 2	PR 2	PR 2	1-10	Usually found in open areas with some trees
Sialia currucoides Mountain bluebird	T 3	T 3	T 3	1-10	Vagrant from west
Myadestes townsendi Townsend's solitaire	T 3	T 3	T 3	8-10	Vagrant from west
Family Sylviidae (gnatcatchers, kinglets, old world warblers)					
Polioptila caerulea Blue-gray gnatcatcher	T-SR 2	T-SR 2	T-SR 2	8-10	

Species	Wa	Ch	Os	Habitat	Comments
Regulus strapa Golden-crowned kinglet	T 2	T 2	T 2	8-10	May overwinter
Regulus calendula Ruby-crowned kinglet	T 2	T 2	T 2	8-10	
Family Motacillidae (pipits, wagtails)					
Anthus spinoletta Water pipit	T 2	T 2	T 2	1-6, 13	Usually found in wet spots
Anthus spragueii Sprague's pipit	T 1	T 1	T 1	1-4	Prefers open prairie
Family Bombycillidae (waxwings)					
Bombycilla garrulus Bohemian waxwing	T 3	T 3	T 4	8-10	Vagrant from south
Bombycilla cedrorum Cedar waxwing	T-WR 2, 3	T-WR 2, 3	T-WR 2	8-10	
Family Laniidae (shrikes)					
Lanius excubitor Northern shrike	T-WR 3	T-WR 3	T-WR 4	1-8	Vagrant from north
Lanius ludovicianus Loggerhead shrike	PR 2	PR 2	PR 2	1-8	
Family Sturnidae (starlings)					
Sturnus vulgaris Starling	PR 2	PR 2	PR 2	5, 6, 8-10	Often found near habitation

Species	Wa	Ch	Os	Habitat	Comments
Family Vireonidae (vireos)					
Vireo griseus White-eyed vireo	T-SR 3	T-SR 3	T-SR 3	10	More common in south
Vireo bellii Bell's vireo	T-SR 2	T-SR 2	T-SR 2	10	
Vireo flavifrons Yellow-throated vireo	T 4	T 4	T-SR 3	10	Vagrant from east and south
Vireo solitarius Solitary vireo	T 3	T 3	T 3	8-10	
Vireo olivaceus Red-eyed vireo	T 2	T 2	T 2	8-10	
Vireo philadelphicus Philadelphia vireo	T 3	3	T 3	8-10	Visitant from east
Vireo gilvus Warbling vireo	T-SR 2	T-SR 2	T-SR 2	10	
Family Parulidae (wood warblers)					
Mniotilta varia Black-and-white warbler	T-SR 2	T-SR 3	T-SR 2	8-10	
Protonotaria citrea Prothonotary warbler	T-SR 2	T-SR 2	T-SR 2	10	Prefers wooded swamps
Helmintheros vermivorus Worm-eating warbler	T 4	T 3	T 4	8-10	Vagrant from south and east
Vermivora pinus Blue-winged warbler	T 3	T 3	T 4	8-10	Vagrant from east

Species	Wa	Ch	Os	Habitat	Comments
Vermivora peregrina Tennessee warbler	T 3	T 3	T 3	8-10	
Vermivora celata Orange-crowned warbler	T 2	T 2	T 2	8-10	May overwinter in southern study area
Vermivora ruficapilla Nashville warbler	T 1	T 2	T 1	8-10	
Parula americana Northern parula warbler	T 3	T 3	T 3	8-10	
Dendroica petechia Yellow warbler	T-SR 1	T-SR 1	T-SR 1	8-10, 13	Often found near water
Dendroica magnolia Magnolia warbler	T 3	T 3	T 3	8-10	
Dendroica coronata Yellow-rumped warbler	T 2	T 2	T 2	8-10	May overwinter
Dendroica virens Black-throated green warbler	T 3	T 3	T 3	8-10	
Dendroica cerulea Cerulean warbler	T 3	T 3	T 3	8-10	Visitant from east
Dendroica fusca Blackburnian warbler	T 3	T 3	T 3	8-10	Visitant from east
Dendroica pensylvanica Chestnut-sided warbler	T 4	T 3	T 3	8-10	Visitant from east
Dendroica castanea Bay-breasted warbler	T 3	T 3	T 3	8-10	Visitant from east
Dendroica striata Blackpoll warbler	T 3	T 3	T 3	8-10	Visitant from east; absent in fall

Species	Wa	Ch	Os	Habitat	Comments
Dendroica pinus Pine warbler	T 4	T 3	T 3	8-10	Visitant from south
Dendroica discolor Prairie warbler	T 3	T 3	T 3	8	Visitant from south
Dendroica palmarum Palm warbler	T 3	T 3	T 3	8-10	
Seiurus aurocapillus Ovenbird	T 3	T 3	T 3	8-10	
Seiurus noveboracensis Northern waterthrush	T 3	T 3	T 3	10	Prefers wooded streams
Seiurus motacilla Louisiana waterthrush	T 3	T 3	T 3	10	Prefers wooded streams
Oporornis formosus Kentucky warbler	T 3	T 3	T 3	10	Visitant from south
Oporornis agilis Connecticut warbler	T 3	T 3	T 3	8-10	
Oporornis philadelphia Mourning warbler	T 3	T 3	T 3	9, 10	
Geothlypis trichas Common yellowthroat	T-SR 1	T-SR 1	T-SR 1	10-13	Found in thickets usually near water
Icteria virens Yellow-breasted chat	T-SR 3	T-SR 3	T-SR 2	10	Prefers thickets
Wilsonia citrina Hooded warbler	0	0	T-SR 3	8-10	Vagrant from south
Wilsonia pusilla Wilson's warbler	T 3	T 3	T 3	8-10	

Species	Wa	Ch	Os	Habitat	Comments
Wilsonia canadensis Canada warbler	T	T	T	8-10	
Setophaga ruticilla American redstart	T 3	T 3	T 3	8-10	
Family Ploceidae (weaver finches)					
Passer domesticus House sparrow	PR 1	PR 1	PR 1	5, 6, 8	Found primarily near habitation
Family Icteridae (meadowlarks, blackbirds, orioles)					
Dolichonyx oryzivorus Bobolink	T 3	T 3	T 3	1-4	Very erratic in occurrence
Sturnella magna Eastern meadowlark	PR 1	PR 1	PR 1	1-7	
Sturnella neglecta Western meadowlark	T-WR 2	T-WR 2	T-WR 2	1-7	
Xanthocephalus xanthocephalus Yellow-headed blackbird	T 2	T 2	T 2	13	Prefers marshes
Agelaius phoeniceus Red-winged blackbird	T-SR 1	T-SR 1	T-SR 1	5, 6, 13	Found near water; also in grain fields
Icterus spurius Orchard oriole	T-SR 2	T-SR 2	T-SR 2	10	
Icterus galbula Northern oriole	T-SR 2	T-SR 2	T-SR 2	8-10	
Euphagus carolinus Rusty blackbird	T-WR 2	T-WR 2	T-WR 2	10	Prefers wooded swamps

Species	Wa	Ch	Os	Habitat	Comments
Euphagus cyanocephalus Brewer's blackbird	T-WR 2	T-WR 2	T-WR 2	5, 6	Winters in feed lots
Cassidix mexicanus Great-tailed grackle	0	0	T-SR 3	5, 6	Range steadily moving northward
Quiscalus quiscula Common grackle	T-SR 2	T-SR 2	T-SR 2	5, 6, 8, 10	
Molothrus ater Brown-headed cowbird	PR 1	PR 1	PR 1	5, 6, 8, 10	Nest parasite
Family Thraupidae (tanagers)					
Piranga olivacea Scarlet tanager	T-SR 3	T-SR 3	T-SR 3	8-10	Vagrant from east
Piranga rubra Summer tanager	T-SR 3	T-SR 3	T-SR 3	8-10	
Family Fringillidae (grosbeaks, sparrows, buntings)					
Cardinalis cardinalis Cardinal	PR 2	PR 2	PR 2	8-10	Often found near habitation
Pheucticus ludovicianus Rose-breasted grosbeak	T-SR 3	T-SR 3	T-SR 3	8-10	
Pheucticus melanocephalus Black-headed grosbeak	T 3	T 3	T 3	8-10	Vagrant from west
Guiraca caerulea Blue grosbeak	T-SR 3	T-SR 3	T-SR 2	8-10	

Species	Wa	Ch	Os	Habitat	Comments
Passerina cyanea Indigo bunting	T-SR 2	T-SR 2	T-SR 2	8-10	
Passerina ciris Painted bunting	T-SR 3	T-SR 3	T-SR 2	8-10	More abundant in south
Spiza americana Dickcissel	T-SR 1	T-SR 1	T-SR 1	1-6	Prefers grassland with some small bushes
Hesperiphona vespertina Evening grosbeak	T 3	T 3	T 3	8-10	Vagrant from north
Carpodacus purpureus Purple finch	T-WR 3	T-WR 3	T-WR 3	8-10	
Acanthis flammea Common redpoll	T-WR 3	T-WR 4	0	8-10	Vagrant from north
Spinus pinus Pine siskin	T-WR 2	T-WR 2	T-WR 2	8-10	
Spinus tristis American goldfinch	PR 2	PR 2	PR 2	8-10	Much less common in winter; often found in open fields
Loxia curvirostra Red crossbill	T 3	T 3	T 3	8-10	Vagrant from north
Chlorura chlorura Green-tailed towhee	T 4	T 4	0	8-10	Accidental visitant from west
Pipilo erythrophthalmus Rufous-sided towhee	T-WR 2	T-WR 3	T-WR 2	9, 10	
Calamospiza melanocorys Lark bunting	T 3	T 3	T 3	1-4	Visitant from west
Passerculus sandwichensis Savannah sparrow	T 2	T 2	T 2	1-7	

Species	Wa	Ch	Os	Habitat	Comments
Ammodramus savannarum Grasshopper sparrow	T-SR 1	T-SR 1	T-SR 1	1-4	
Ammodramus bairdii Baird's sparrow	T 3	T 3	T 3	1-4	Vagrant from west
Ammodramus henslowii Henslow's sparrow	T-SR 3	T-SR 3	T-SR 3	4	Prefers old fields
Ammospiza caudacuta Sharp-tailed sparrow	T 3	T 3	T 3	13	Prefers marshes
Ammospiza leconteii LeConte's sparrow	T 3	T 3	T 3	1-4	May overwinter in the Osage study area
Pooecetes gramineus Vesper sparrow	T 2	T 2	T 2	1-7	
Chondestes grammacus Lark sparrow	T-SR 1	T-SR 1	T-SR 1	1-8	
Junco hyemalis Dark-eyed junco	T-WR 2	T-WR 2	T-WR 2	8-10	
Spizella arborea Tree sparrow	T-WR 1	T-WR 1	T-WR 1	8-10	Often found in hedgerows
Spizella passerina Chipping sparrow	T-SR 2	T-SR 2	T-SR 2	8-10	
Spizella pusilla Field sparrow	T-SR 2	T-SR 2	T-SR 2	1-8	Prefers thicket at prairie edge
Spizella pallida Clay-colored sparrow	T 2	T 2	T 2	8-10	
Zonotrichia querula Harris' sparrow	T-WR 1	T-WR 1	T-WR 1	8-10	Often found in hedgerows

Species	Wa	Ch	Os	Habitat	Comments
Zonotrichia leucophrys White-crowned sparrow	T-WR 2	T-WR 2	T-WR 2	8-10	Often found in hedgerows
Zonotrichia albicollis White-throated sparrow	T 2	T 2	T 2	8-10	Prefers lowland forest
Passerella iliaca Fox sparrow	T-WR 3	T-WR 3	T-WR 2	8-10	
Melospiza lincolnii Lincoln's sparrow	T-WR 2	T-WR 2	T-WR 2	8-10	Often found near water in thickets
Melospiza geogiana Swamp sparrow	T 3	T 3	T 3	10-12	
Melospiza melodia Song sparrow	T-WR 2	T-WR 2	T-WR 2	8-10	Usually found in heavy cover
Calcarius mccownii McCown's longspur	T-WR 3	T-WR 3	T-WR 3	1-3	
Calcarius lapponicus Lapland longspur	T-WR 1	T-WR 1	T-WR 1	1-3	May occur in huge flocks
Calcarius pictus Smith's longspur	T-WR 3	T-WR 3	T-WR 2	1-3	
Calcarius ornatus Chestnut-collared longspur	T-WR 3	T-WR 3	T-WR 3	1-3	

MAMMALS

This portion of the report indicates the possible or probable abundance and distribution of mammals within the three study areas. The primary sources of information for this report are Cockrum (1952), Hall (1955), and Hall and Kelson (1959). Other resources utilized were Frydendall (1969), Gier (1967), Platt et al. (1973a and 1973b), and Risser (1974). No recent comprehensive works are available.

In Kansas and adjacent northeastern Oklahoma, approximately 90 species and subspecies of mammals are reported to occur or have occurred. Not all species occur in any of the proposed study areas, as shown below:

Study Area	Probable Species	Possible Reintroductions
Wabaunsee	54	7
Chase	50	7
Osage	50	7

All three study areas are in what is referred to as the Flint Hills formation of Kansas. This is an intergrade area for eastern and western species, and precise faunal assessment is difficult because a small change in east-west direction can result in great faunal changes. Most differences of faunal composition in the study areas are due to the north-south distribution of animals. The study areas are characterized by large areas of grasslands, few upland forest areas, and some riparian woodlands in intermittently and permanently flowing drainages. Some rocky outcroppings exist in all three study areas.

Rare and Endangered Species (extracted from Platt et al., 1973a and 1973b).

Rare or endangered species:

Mustela nigripes (Black-footed ferret) – endangered

Species endangered in Kansas but not nationally:

Tamias striatus (Eastern chipmunk)

Species rare in study areas but not nationally:

(A rare species is one that although not threatened with extinction is present in such small numbers throughout its range that it may soon become endangered if its environment worsens.)

Marmota monax (Woodchuck)
Citellus franklinii (Franklin's ground squirrel)
Glaucomys volans (Southern flying squirrel)
Spilogale putorius (Spotted skunk)
Lynx rufus (Bobcat)

Extirpated Species and Possible Reintroductions

Cynomys ludovicianus ludovicianus **(Black-tailed prairie dog):** There is some question as to whether the black-tailed prairie dog ever occupied any of the study areas. The range for this species in Hall (1955) indicates that the black-tailed prairie dog has been found as far east as the western edge of Cowley County, Kansas, and the middle of Washington County, Kansas. This places the species within 10 miles of the Chase study area, 30 miles of the Wabaunsee study area, and 35 miles of the Osage study area. Because of the proximity of the documented former range of *C. ludovicianus*, it is possible that the species may have inhabited one or more of the study areas in the past. This idea is supported indirectly by the statement in Hall (1955) that "in the long grass areas of Kansas, prairie dogs lived where the bison cropped the grass short and trampled the soil until it was hard." All three study areas lie within the range originally occupied by the bison.

Prairie dogs are herbivores, and require firm ground in shortgrass prairie or other grassy areas grazed short by herbivores. They mate from February through April, the gestation period is 28-32 days, the young are born in an underground nest, and the number of young born is 2-10 (5-6 average).

It may be possible to establish prairie dog populations in any one of the three study areas.

Canis lupus **(Gray wolf):** This species has been eliminated along with the bison from study areas. Gray wolves formerly ranged throughout all three study areas, and fed on any flesh available.

Gray wolves require large populations of other large mammals and large unrestricted range. They mate from December through February, gestation period is 62-66 days, the young are born in an underground den, and the number of young born is 3-13 (6-8 average); wolves will hybridize with domestic dogs.

The likelihood of successful gray wolf reintroduction is very small, as the study areas are too small to provide unrestricted range and sufficiently large populations of prey. The gray wolf's home range is reported to be as large as 50 miles in diameter (Murie 1944), and the animal runs naturally in packs.

Mustela nigripes **(Black-footed ferret):** It is commonly thought that before extirpation *M. nigripes* fed rather exclusively on the black-tailed prairie dog and dwelled in the burrows of the same animal. There appears to be no reason to doubt this theory.

Ferrets require large populations of black-tailed prairie dogs *(Cynomys ludovicianus)*, and the likelihood of successful ferret reintroduction is poor because no such

populations exist in the study areas. Ferrets may not have occupied the three study areas, but most likely did if black-tailed prairie dogs were present in large numbers.

Lutra canadensis **(River otter):** The former range of the river otter included all the present study areas. This species is now extinct in Kansas, probably as a result of trapping for the fur trade.

Otters require permanent streams with adequate populations of fish, frogs, and invertebrates, as well as protection from trapping. Their young are born in the spring, and the litter usually includes 2-3 young.

The likelihood of successful otter reintroduction seems good if permanent streams are maintained in the study areas. However, they probably should not be reintroduced before stream erosion is stabilized.

Felis concolor **(Mountain lion):** This species is extinct in Kansas. Its former range included all of Kansas.

Mountain lions require large unrestricted range (30- to 50-mile radius – Caras 1967), and large populations of other large mammals; deer are said to be their primary prey. Females carry their young for 96 days, and bear 1-6 cubs (2 average) in sheltered areas.

The likelihood of successful mountain lion reintroduction is poor due to insufficient range in each study area.

Ursus americanus **(Black bear):** Black bears are no longer present in Kansas, although they may have roamed the entire state as late as the 1870s. They probably inhabited wooded areas and rocky canyons in all three study areas.

Black bears require timber and brush areas with suitable den sites, such as caves or soft earth. They are omnivores and often inhabit garbage dumps near human habitations. They mate in August and September, the gestation period is 6.5 months, and the number of young born is 1-5 (2 average).

A small population of black bears might be successfully reintroduced, although sufficient habitat is likely lacking. Their home range often extends to a radius of 10 miles or more (Caras 1967).

Ursus horribilis **(Grizzly bear):** There seem to be divergent views concerning whether or not the grizzly bear inhabited Kansas as far east as the present study areas.

Grizzlies require extensive free range (home range extends to a radius of 20 miles or more – Caras 1967) and large populations of prey. They mate in July and August, the gestation period is 6 months, and the number of young born is 2-4 (usually 3, and rarely 4).

It is doubtful that successful grizzly bear reintroduction could be accomplished. Further, residents in areas immediately adjacent to the park could be expected to object to the introduction of this large predator.

Cervus canadensis **(Wapiti):** Although extinct in Kansas, wapiti once ranged throughout the state.

Wapiti require grasslands interspersed with trees and shrubs; in the summer they seek moist places for wallows. They mate in autumn, the gestation period is 8.5 months, and the calves weigh 30-40 lbs. Females are uniparous (rarely bearing twins), and three-fourths of them have their first calves at age 3.

The likelihood of successful Wapiti reintroduction is excellent.

Antilocapra americana **(Pronghorn):** Pronghorns were probably common as far east as eastern Kansas in the early 1800s (Cockrum 1952), but may not have ranged into the present Osage study area.

This species requires open grasslands with browse plants. Females usually first breed at 14-16 months, their gestation period is 230-240 days, and the number of young is 2 (1 less often).

The likelihood of successful reintroduction should be good if a rather large unrestricted range is available; however, cool spring weather and rains may cause high mortality rate in young born that year (personal communication, Gene Bartnicki).

Bison bison **(American bison):** The American bison was the dominant large vertebrate herbivore on all study-area lands when they were in a primal state.

Bison require open grasslands interspersed with trees, although timber may not be necessary. They mate from July through September, the gestation period is 9.5 months, and they normally bear 1 young (rarely 2).

There is an excellent possibility of successful bison reintroduction. A large unrestricted range should be available to them.

Management Considerations

The management of large mammalian herbivores and predators is a complex science. Before precise relationships and more than cursory opinions on feasibility of reintroductions can be made, a thorough study of the habitat should be undertaken. Topography and productivity should be well known prior to large mammal introduction. The Wichita Mountains Wildlife Refuge in southern Oklahoma is an example of a midgrass prairie area that supports populations of large mammalian

herbivores. The preserve encompasses approximately 60,000 acres – about the size of the Wabaunsee study area. A conversation with Mr. Gene Bartnicki, the resident biologist at the Wichita Mountains refuge, revealed some of the following management considerations, which may be relevant to this report.

Stocking rates are based on grassland productivity in a drought year and on the assumption that the grazer population should remove only one-third of the forage production. Soil types and other physical parameters largely determine productivity, but the average refuge productivity results in about 20 acres required for each animal unit. One animal unit is 1,000 pounds of animal. The average bison is 1.5 units and the average wapiti is 0.5 units; seven deer or seven antelope comprise 1 animal unit. Other considerations must also be taken into account. For instance, bison appear to graze on some sites preferentially, resulting in overgrazing in some areas and little grazing in others. Additionally, elk require browse, and if it is not present in the area, it must be provided or successful reintroduction is unlikely.

Concerning predator reintroduction, Mr. Bartnicki suggested that the 60,000-acre refuge was probably too small for a population of mountain lions or gray wolves. Perhaps the larger two study areas might support a few mountain lions or wolves; however, the likelihood of successful reintroduction is slight. Further, considering the wide rangings of large predators, it would be rather difficult to ensure that the predators did not escape onto adjoining ranchlands and cause stock damage as well as bad public relations.

Given the information available, and the lack of specific information about the study areas, it is not possible to make firm recommendations on reintroductions. These should only be made after careful on-site research.

Table 5. Account of mammals by study area.

KEY

ABUNDANCE

1 = Common: Present in large numbers throughout much of the study area

2 = Occasional: Present in small numbers in much of the area or possibly in large numbers in limited habitats

3 = Rare: When present, only in very small numbers

4 = Possible: Known to occur in the general geographic region, but status on the study area unknown

5 = Extirpated

0 = Absent

HABITAT

Habitat categories and their criteria are shown in table 1. Where necessary, appropriate microhabitat preferences are provided in a "Comments" section.

* See extirpated species and possible reintroduction section.

Species	Wa	Ch	Os	Habitat	Comments
Family Didelphiidae (Opossums)					
Didelphis marsupialis virginianus Opossum	1	1	1	8-10	
Family Soricidae (shrews)					
Blarina brevicauda carolinenis Short-tailed shrew	1	1	1	1-6, 8-10	May be involved in insect control; saliva toxic to some animals
Cryptotis parva parva Little short-tailed shrew	1	1	1	8-10	Smallest mammal in state
Family Talpidae (moles)					
Scalopus aquaticus micrinoides Eastern mole	1	1	1	1-6, 10	May eat earthworms and a small amount of vegetable material
Family Vespertilionidae (plainnose bats)					
Myotis lucifugus lucifugus Big myotis	3	3	3	14	
Myotis velifer incautus Cave myotis	0	0	4	14	Near edge of distribution
Myotis keeni septentrionalis Keen's myotis	4	0	0	14	
Pipistrellus subflavus subflavus Pipistrelle	2	2	2	14	Smallest bat in Kansas; hibernates Oct.-Apr.
Eptesicus fuscus fuscus Big brown bat	2	2	2	14	

Species	Wa	Ch	Os	Habitat	Comments
Nycticeius humeralis humeralis Evening bat	3	3	3	14	
Lasionycteris noctivagans Silvery-haired bat	3	3	3	8-10	Not usually found because of solitary retiring habits
Lasiurus cinereus cinereus Hoary bat	3	3	3	8-10	Migrates in winter
Lasiurus borealis borealis Red bat	1	1	1	8-10	Usually active in early evening
Family Molossidae (freetail bats)					
Tadarida brasiliensis mexicana Brazilian free-tailed bat	2	2	2	14	Summer resident only
Family Dasypodidae (armadillos)					
Dasypus novemcinctus mexicanus Nine-banded armadillo	4	4	3	1-6	
Family Leporidae (hares, rabbits)					
Sylvilagus floridanus Eastern cottontail	ssp *alacer* 1	ssp *mearnsii* 1	ssp *mearnsii* 1	8-10	
Lepus californicus melanotis Black-tailed jackrabbit	1	1	1	1-6	

Species	Wa	Ch	Os	Habitat	Comments
Family Sciuridae (squirrels)					
Sciurus carolinensis carolinensis Gray squirrel	3	3	3	9	
Sciurus niger Fox squirrel	1	1	1	8-10	Common tree squirrel
Marmota monax Woodchuck	3	3	3	1-6	All three study areas near westernmost extension of range
Cynomys ludovicianus ludovicianus *Black-tailed prairie dog	0	0	0	1, 2	May have been present on all three study areas when bison kept grass somewhat cropped; however, it would have been the easternmost extension of the range
Spermophilus tridecemlineatus 13-lined ground squirrel	ssp *texensis* 1	ssp *texensis* 1	ssp *tridecemlineatus* 1	2, 3, 5	Usually solitary
Spermophilus franklinii Franklin's ground squirrel	3	3	3	1, 4	Solitary to loosely colonial
Glaucomys volans volans Southern flying squirrel	4	4	4	9, 10	Near westernmost range extent
Family Geomyidae (pocket gophers)					
Geomys bursarius majusculus Plains pocket gopher	1	1	0	1-6	Beneficial to aeration and penetration of non-cultivated soil
Family Heteromyidae (pocket mice, kangaroo mice, kangaroo rats)					
Perognathus hispidus spilotus Coarse-haired pocket mouse	4	4	1	3-5	Near easternmost extent of range

Species	Wa	Ch	Os	Habitat	Comments
Family Castoridae (beavers)					
Castor canadensis missouriensis Beaver	3	3	3	11, 12	
Family Cricetidae (mice, rats, lemmings, voles)					
Onychomys leucogaster breviauritus Northern grasshopper mouse	4	4	4	1, 4, 5	Nocturnal; near easternmost extent of range
Reithrodontomys fulvescens aurantius Fulvous harvest mouse	0	4	4	1, 4-6, 10	Southern study areas near extent of range
Reithrodontomys megalotis dychei Western harvest mouse	1	0	0	1, 4, 5	
Reithrodontomys montanus griseus Plains harvest mouse	1	1	4	1, 4	Osage study area near southeast extent of range
Peromyscus maniculatus bairdii Deer mouse	1	1	1	1, 3-5	
Peromyscus leucopus noveboracensis Woods mouse	1	1	1	8-10	
Peromyscus boylii attwateri Brush mouse	0	0	4	7-9	
Sigmodon hispidus texianus Hispid cotton rat	1	1	1	1, 3-6	
Neotoma floridana osagnesis Eastern wood rat	1	1	1	7-10	
Synaptomys cooperi gossi Southern lemming-mouse	4	4	0	1, 3-5	

Species	Wa	Ch	Os	Habitat	Comments
Ondatra zibethicus	ssp *zibethicus*	ssp *cinnamominus*			Only found where water is permanent
Muskrat	1	1	1	11-13	
Microtus ochrogaster ochrogaster Prairie vole	1	1	1	1, 4	Burrows and runways
Microtus pinetorum nemoralis Pine vole	3	3	3	8-10	Near westernmost extent of range
Family Muridae (old world rats and mice)					
Rattus norvegicus norvegicus Norway rat	1	1	1	14	
Mus musculus House mouse	1	1	1	1-10, 14	
Family Zapodidae (jumping mice)					
Zapus hudsonius pallidus Meadow jumping mouse	3	3	3	1-10	
Family Erethizontidae (porcupines)					
Erethizon dorsatum bruneri Porcupine	4	4	4	8-10	Near southeasternmost extent of range
Family Canidae (dogs, wolves, foxes)					
Canis latrans Coyote	1	1	1	1, 4, 5, 7	Largest extant carnivore in Kansas; commonly present but not readily seen

Species	Wa	Ch	Os	Habitat	Comments
Canis familiaris Feral and domestic dogs	1	1	1	1-10, 14	
Canis lupus nubilus *Gray wolf	5	5	5	1-10	
Vulpes fulva fulva Red fox	4	4	4	1-10	
Urocyon cinereoargenteus ocythus Gray fox	4	4	4	7-10	May now be extinct, but not verified
Family Ursidae (bears)					
Ursus americanus americanus *Black bear	0	0	0	8-10	
Ursus horribilis *Grizzly bear	5	5	5	1-10	
Family Procyonidae (raccoons, coatis)					
Procyon lotor hirtus Raccoon	1	1	1	1-10	
Family Mustelidae (weasels, skunks, mink, badgers, otters)					
Mustella vison letifera Mink	3	3	3	11-12	
Mustella frenata primulina Long-tailed weasel	1	1	1	1-10	
Mustella nigripes *Black-footed ferret	0	0	0	1, 2	

Species	Wa	Ch	Os	Habitat	Comments
Taxidea taxus taxus Badger	1	1	1	1-6	Range coincides with that of woodchuck
Mephitis mephitis Striped skunk	ssp *mesomelas* 1	ssp *avia* 1	1	1-10	
Spilogale putoris interrupta Spotted skunk	3	3	3	1-10	
Lutra canadensis interior *River otter	5	5	5	11, 12	Extinct in Kansas
Family Felidae (cats)					
Felis concolor hippolestes *Mountain lion	5	5	5	1-10	Extinct in Kansas
Felis domestica Feral and domestic cats	1	1	1	1-10, 14	
Lynx rufus rufus Bobcat	3	3	3	1-10	
Family Cervidae (deer)					
Cervus canadensis canadensis *Wapiti	5	5	5	1, 4, 8-10	Extinct in Kansas
Odocoileus virginianus macrourus White-tailed deer	1	1	1	8-10, 14	

Species	Wa	Ch	Os	Habitat	Comments
Family Antilocapridae (antelope)					
Antilocapra americana americana *Pronghorn	0	0	0	1, 3, 4	Extinct in Kansas; may have been on Wabaunsee and Chase study areas when present in state
Family Bovidae (cattle, bison, goats, muskox, sheep)					
Bison bison bison *American bison	5	5	5	1, 10	Once widely distributed, now extinct except for preserves and private herds

ARTHROPODS

Most of the native grassland lies west of the Mississippi River, and it is logical that this region has produced the bulk of research and observations on grassland insects. However, the majority of the information is related to the "destructive plagues" that have resulted in economic losses when man has attempted to divert the use of this biome for his purposes without understanding the biological principles involved. Arthropods then are a dynamic but poorly understood component of the grassland biome.

Attempts to understand and assess the importance of insects in the grassland biome is difficult. An investigator soon comes to the conclusion that no more than a meager beginning has been made in exploring the complexities of the floral and faunal relationships. A good example of this occurred in a New Mexico range grass nursery a few years ago. Six previously undescribed species of *Diptera* and *Hymenoptera,* including an undescribed genus, were found to attack one or more grasses in moderate to large numbers. Three of these new species severely reduced seed production!

Although the number of species reported in the previous sections is relatively small, the list of species of arthropods would be so extensive that no one individual could attempt to compile it. Because of the vast numbers involved and the amount of time required, the family will – for practical purposes – be the smallest unit discussed. Generally speaking, species uniformity among arthropods in any one of the three tentative sites would be essentially the same. There is no solid agreement upon the number of arthropod species in the world, but a conservative estimate would be approximately 2 million species. In areas the size of the three study areas, several thousands of species could be involved. Despite these numbers, it is probable that no species have been exterminated by cultural or agricultural processes except certain ectoparasites that were confined to now-extirpated vertebrate hosts such as the bison, the gray wolf, and possibly the prairie dog.

The members of the phylum *Arthropoda* have segmented appendages, as well as segmented bodies of two or three more or less distinct body regions. The chitinous exoskeletons are periodically shed and renewed as the animals grow. Certain characteristic internal organs are associated with this phylum of animals.

The various groups of arthropods are classified in different ways by authorities. No one system of classification is universally recognized and accepted. The arthropods dealt with in this section are those associated with terrestrial and freshwater habitats. No attempt will be made to tabulate them according to habitat distribution because so many of the arthropods are widely dispersed.

Class *Crustacea*

The class *Crustacea* is usually divided into a series of subclasses. These arthropods are characterized generally by two pairs of antennae, biramus appendages, and the body fused into a cephalothorax and an abdomen. For the most part, those found in the study areas would be confined to the fresh water; only one or two representatives are terrestrial.

Subclass *Branchiopoda*

Order *Anostraca* **(fairy shrimps)**

Order *Notostraca* **(tadpole shrimps)**

Order *Conchostraca* **(clam shrimps)**

Order *Cladocera* **(water fleas)**

Subclass *Ostracoda* **(ostracods)**

Order *Podocopa* **(seed shrimps)**

Subclass *Copepoda* **(copepods)**

Order *Eucopepoda* **(true copepods):** No paired compound eyes, genital opening on last thoracic somite. *Diaptomus* and *Cyclops* found in fresh water, *Asteroceres* parasitic on invertebrates. The genus *Lernaea* found in fresh water is parasitic on fishes and the genus *Choniostoma* parasitic on crustaceans.

Order *Branchiura* **(fish lice):** Body flat, carapace disclike, compound eyes. *Argulus* parasitic on fishes of fresh and salt waters.

Subclass *Malacostraca* **(crayfish, lobsters, and crabs)**

Order *Isopoda* **(equal foot-pill or sow bugs):** Body usually depressed dorsoventrally, no carapace, abdomen short and partly or all fused. Occasionally found in fresh waters among plants or under stones, some forms are terrestrial. Many species parasitic on fish and other crustaceans. Terrestrial forms *Onicus asellus* and *Porcellio scaber* commonly known as sow bugs, *Armadillium vulgare* the common pill bug of the Midwest and Southwest that rolls into a ball when disturbed. Can be abundant, live mostly on decaying organic matter.

Order *Amphipoda* **(double-foot amphipods)**

Order *Decapoda* **(crayfish)**

Class *Diplopoda* (Millipedes)
The millipedes are elongate, wormlike animals with many legs. The name is derived from *diplo,* two or double, and *poda,* foot or appendage, (referring to the fact that most body segments bear two pairs of legs). Most millipedes have thirty or more pairs of legs; the body is cylindrical or slightly flattened. The antennae are short and usually seven-segmented. The external openings of the reproductive system are located at the anterior end of the body, between the second and third pair of legs. Compound eyes are usually present, each consisting of a group of ocelli.

The head in most millipedes is convex above and flat beneath. Millipedes are usually found in damp places, under leaves, in moss, under stones, in rotting wood, or in the soil. Most millipedes are scavengers and feed on decaying plant material, but a few attack living plants and sometimes do serious damage to young plants. A few millipedes are predaceous; these animals winter as adults in protected areas, and lay their eggs in the summer. Some construct nestlike cavities in the soil in which they deposit their eggs; others lay their eggs in damp places without construction of any sort of nest.

There are a number of arrangements for the orders within the family; however, only one or two are of importance here and thus are the only ones designated.

Order *Spirobolida (spiro,* spiral; *bolida,* throw)

Order *Spirostreptida (spiro,* spiral; *streptida,* twisted)

Class *Chilopoda* (Centipedes)
The name for this class is derived from *chilo* meaning lip and *poda* meaning foot or appendage (referring to the fact that the poison jaws are modified legs). The centipedes are elongate, flattened, wormlike animals with 15 or more pairs of legs. Each body segment bears a single pair of legs; the last two pairs are directed backwards and are often different in form from the other pairs. The antennae consist of 14 or more segments. The genital openings are located at the posterior end of the body, usually on the next to the last segment.

Centipedes are found in a variety of places, but usually occur in protected areas such as under stones or bark, or in rotten logs. They are very active cursorial animals and are predaceous. They feed mostly upon insects, spiders, and other small animals. All centipedes possess "poison jaws" with which they paralyze their prey. Certain of the larger species have sufficient venom to produce acute illness in man. Centipedes winter as adults in protected areas, and lay their eggs during the summer.

Four orders of *Chilopoda* generally are considered to occur in the United States, three of which may be encountered in the study areas.

Order *Lithobiomorpha* **(literally means stone-like form)**

Order *Scolopendromorpha:* The scolopendrids are mainly tropical, and in the United States occur primarily in the southern states. However, one of the largest forms, *Scolopendra,* occurs in southern Kansas. This is one of the most venomous of the centipedes and the bite is painful. They are efficient predators and are known to handle large spiders and even small reptiles.

Order *Geophilomorpha* **(name implies earth-loving forms)**

Class *Pauropoda* **(Pauropods)**

Class *Symphyla* **(Symphylids)**

Class *Tarigarada*

Class *Arachnidae* **(Arachnids – Spiders, Scorpions, Mites, and Ticks)**
The bodies of the members of this group are usually composed of two divisions, the cephalothorax and the abdomen. Antennae are absent and eyes are simple. Four pairs of legs are attached to the cephalothorax in the adult stage. The class is usually terrestrial, although some are found in fresh water and some are parasitic, breathing by trachea or book lungs.

The arachnids are divided into a number of orders, six of which are mentioned here.

Order *Scorpionidea* **(scorpions):** Scorpions are well-known animals that occur in the southwestern and western parts of the United States. They are fair sized arachnids, varying in length from 4 to 5 inches. The pedipalps are large and clawlike. The abdomen is broadly joined to the cephalothorax and is differentiated into two portions, a broad seven-segmented anterior portion and a much narrower five-segmented posterior portion that terminates in a sting and is usually curved in a dorsal anterior position.

Scorpions are nocturnal in habit and are predaceous, feeding largely on insects, spiders, and other small animals that they capture with their pedipalps and kill with their sting. The effect of the scorpion sting depends primarily upon the species of scorpion involved. Two species belonging to the genus *Centruroides* and occurring in Arizona are poisonous. Those forms belonging in Kansas and in Oklahoma are in the genus *Vejois;* their sting, although painful, is not harmful to man. Scorpions are usually found under stone slabs or in similar habitats. If a scorpion is found on one's body, it should be brushed off rather than swatted.

Order *Solpugida* **(sun scorpions):** These arachnids occur chiefly in desert regions. However, one species of the genus *Ammotrecha* is encountered

occasionally throughout central Oklahoma and southern Kansas. The body of the sun, or wind, scorpion may be 25 mm. or more in length and is somewhat constricted in the middle. The chelicerae are very large, give the animals a ferocious appearance, and are in part the reason for the name, meaning "venomous spider or ant." However, these arachnids do not possess venom glands. The sun scorpions are nocturnal and are very active and fast moving. They are predaceous on other small animals.

Order *Pseudoscorpionida* (pseudoscorpions): The pseudoscorpions are small arachnids seldom more than 5 mm. in length. They resemble true scorpions because of their large clawlike pedipalps, but the abdomens are short and oval and they have no sting. The pseudoscorpions have very flat bodies well adapted to the habitats where they are usually encountered – under bark, between boards, in moss, and in nests of various rodents, particularly those of the wood rat.

Order *Phalangida* (harvestmen or daddylonglegs)

Order *Acarina* (mites and ticks): The order *Acarina* constitutes a large group, principally of small to minute animals. Their bodies are usually oval and compact, with little or no differentiation of cephalothorax and abdomen. Newly hatched young, called larvae, usually have only three pairs of legs and acquire the fourth pair after the first molt. Instars (between larvae and adults) are called nymphs.

The otrder *Acarina* in all probability rivals the class *Insecta* in the number of species and variety of habitats occupied. The order includes both terrestrial and aquatic forms. They are abundant in soils and organic debris where they usually outnumber other arthropods. Many are parasitic, at least during part of their life cycles; both vertebrates and invertebrates serve as hosts. Most of the parasitic forms are external parasites. The free living forms may be predaceous or phytophagous, although some are scavengers. This group is of considerable biological interest and economic importance, but it is poorly understood. The scheme of classification presented here is a reasonably elementary one, because specialists cannot agree upon the general groupings within the order.

Suborder *Notostigmata*

Suborder *Parasitiformes*

Group A *Mesostigmata*

Group B *Ixodidae* (ticks): The two families of ticks that occur in North America are also found in this area. The *Ixodidae* are commonly

known as hard ticks, dog ticks, or wood ticks, and the *Argasidae* are the soft ticks. Ticks are larger than most mites, generally lacking bristles, and are all parasitic during part of their life cycles, attacking mammals, birds, and reptiles.

Ticks are important as vectors of certain diseases. The American dog tick *Dermacentor variabilis* (Say) is found in wooded-ravine habitats. At times, populations of this tick can be remarkably abundant and are efficient vectors of Rocky Mountain spotted fever. In fact, the Rocky Mountain spotted fever occurring in Oklahoma and Kansas is associated with this tick and the ravine habitat. Adults of this species parasitize large mammals, especially the *Canidae.* They attack humans, although not with the same avidity; nonetheless, they are associated with man often enough to transmit the organisms of Rocky Mountain spotted fever. Consistently, the larvae and nymphs of the genus *Dermacentor* are associated with small mammals such as *Microtus* and *Peromyscus.* Two other genera of hard ticks encountered in the study sites are *Haemaphysalis* and *Ixodes.* Members of the first genus will be confined to lagamorphs, and the second on a wide variety of vertebrate animals. *Haemaphysalis* does not attack man; sufficient knowledge is not available concerning the *Ixodes* to give reliable information.

The *Argasidae,* or soft ticks, are most commonly encountered in bat caves and are associated with rodent nests, particularly those of the wood rat *(Neotoma).* They are capable of transmitting relapsing fever to man; however, while this was a common occurrence during the middle and late 40s, relapsing fever has essentially disappeared as a reportable disease in Kansas and Oklahoma. If prairie dogs were introduced into the area, consideration should be given to ensure that the specimens of prairie dogs obtained for colonization were not infested with immature soft ticks *(Ornithodorous turicata).*

Suborder *Acaraforimes*

Group A: This group includes the mange, itch, feather and other mites. Some members of this group cause dermatitis in animals, particularly the families *Scarcoptidae* and *Psoropitidae.*

Group B – *Tarsonemini:* This group includes small plant-associated mites that are sometimes free living or associated with insects.

Group C – *Tetrapodili* (gall mites): The gall mites are elongate and wormlike, and have two pairs of legs. Some species form small

pouchlike galls on leaves, some produce blister-like galls on the leaves, some produce a rusting of leaves, and some attack bugs. Many are serious pests of trees or other cultivated plants.

Group D – *Prostigmata* (chigger mites): This is a large group containing predaceous, scavenging, plant-feeding, and parasitic forms. The best known mites in this group are the spider mites, harvest mites, water mites, and chiggers. The chigger *(Eutrombicula alfreddugesi* – Oudemans) is parasitic in the larval stage, and is not host-specific. Therefore, it attaches to a wide variety of vertebrate animals including man. The bite of the chigger is discomforting, and complaints are routinely received from tourists during the larvae season, which usually runs from May through September. The nymphs and adults are predaceous upon other insects.

Group E – *Oribatei* (oribatid mites): The oribatids are small, oval mites that superficially resemble beetles. Some species have winglike lateral extensions of the notum. Oribatid mites are found in leaf litter, under bark, under stone, in moss, in freshwater plants, and in the soil. Apparently all are scavengers, and make up a large percentage of the soil fauna. They are important in promoting soil fertility through a breakdown of organic matter. These mites have been estimated at 69 million per acre (Baker and Owl 1956) on or below the surface of the soil. They serve as intermediate hosts of various tapeworms that parasitize mammals including ungulates. Englemann (1968) suggested that 22 percent to 33 percent of the soil-mite fauna is herbiverous, feeding on fungi and bacteria that break down dead organic matter.

Order *Araneida* (spiders): The spiders are a large, distinct, and widely spread group. They occur in many types of habitats and are often abundant. Many people have the idea that spiders are highly venomous, but only certain species are actually harmful to humans.

Suborder *Avicularoidea*

Family *Ctenizidae:* This family includes the trap door spiders, so called because they construct burrows in the ground that are closed by a door hinged with silk. The door fits snugly and is usually camouflaged on the outside. The tunnels may be simple or branched, or they may contain side chambers that are closed off from the main tunnel by hinged doors. These spiders are common in Oklahoma and Kansas.

Family *Avicularidae:* Avicularidae includes the tarantulas, the largest of our spiders. These spiders are greatly feared, but the U.S. species are

actually less venomous than the much smaller black widow spider. Professor Baerg at the University of Arkansas has studied these forms extensively. A female is 7 years old before becoming sexually mature and may live as long as 28 years.

Family *Dipluridae*

Family *Atipidae*

Family *Antrodiaetidae*

Suborder *Argiopoidea:* These spiders burrow in the ground and the burrows are closed by a double door that meets in the middle of the opening. These spiders differ from the *Avicularoidae* in that their chelicerae move laterally and they are generally smaller. This suborder is divided into two sections.

Section *Cribellatae* (hackled bound weavers)

Family *Amaurobiidae*

Family *Ulobridae*

Family *Dictynidae*

Family *Zoropsidae*

Section *Ecribellatae*

Family *Dysderidae*

Family *Oonopidae* (minute jumping spiders)

Family *Segestriidae* (the segestriids)

Family *Scytodidae* (spitting spiders)

Family *Loxoscelidae* (the loxoscelid spiders): These spiders are light-colored spiders, 6 to 9 mm. in length, that have large and conspicuous colulus. They occur principally in the West and Southwest. A few species in this family are highly venomous. *Loxoscelex reclusus*, commonly known as the brown recluse, is undoubtedly second only to the black widow in this respect. It is slightly smaller than the black widow, and is light fawn to

chocolate brown in color with a wide stripe of darker brown in the anterior part of the cephalothorax. This dark-brown stripe resembles the shape of a fiddle, and is the reason for the common name of "Fiddleback spider." Usually this spider produces a necrotic lesion that requires several weeks to some months to heal. In many instances, skin grafting is required before successful closing of the wound.

Family *Gnaposidae* (hunting spiders)

Family *Pholcidae* (long-legged spiders)

Family *Clubionidae* (the two-clotted hunting spiders): The clubionids are relatively common spiders, 3 to 15 mm. in length. They occur in foliage or on the ground. They do not spin webs for the capture of prey; rather they construct tubular retreats under stones or in rolled-up leaves or folds of grass. One species, *Chiracanthium inclusum,* is quite venomous; this spider is about 8 mm. in length, greenish white in color, and occurs throughout the United States.

Family *Anyphaenidae* (hunting spiders)

Family *Ctenidae* (wandering spiders)

Family *Heteropodidae* (giant crab spiders)

Family *Thomasidae* (crab spiders): The crab spiders are somewhat crablike in shape, and walk sideways or backwards. The two anterior pairs of legs are usually stouter than the posterior pairs. These spiders spin no webs, but forage for their prey or lie in ambush for it. Many species lie in wait for their prey in flowers, and are able to catch flies or bees much larger than themselves. One of the most common of this species is the goldenrod spider *(Misumena vatia),* which is white or yellow with a light red band on either side of the abdomen. This species can change color (over a period of several days) depending on the color of the flower.

Family *Attidae* (jumping spiders)

Family *Agelenidae* (grass and funnel webbed spiders)

Family *Hahniidae* (the hahniids)

Family *Pisauridae* (nursery web and fishing spiders)

Family *Lycosidae* (wolf spiders or ground spiders)

Family *Oxyopidae* (link spiders)

Family *Theridiidae* (the comb footed spiders): The webs of these spiders are irregular networks in which the spiders usually hang upside down. Many live in buildings and other protected places such as rodent burrows. The cephalothorax of this species is usually small, the abdomen large and rounded. The common name of this family is derived from the comb of serrated bristles on the hind tarsae. These combs are used in wrapping the prey with silk. One of the most important species of this group is the black widow spider, *Lacrodectus mactans.* This is the most venomous spider in the United States; however, the bite is rarely fatal. The female is about 12 mm. in body length, black, and shiny with a reddish-orange hourglass-shaped spot on the ventral part of the abdomen. The male is less often seen because it is usually killed by the female after mating; it is about half the size of the female.

Family *Minetidae* (hunting spiders)

Family *Argiopidae* (orb weavers)

Family *Tetragnathidae* (four-jawed spiders)

Family *Linyphiidae* (sheet web spiders)

Class *Insecta* (Hexopoda)

Insects are characterized as arthropods in which the body is divided into a head, thorax, and abdomen. They breathe by means of a tracheal system, have three pairs of legs, and one pair of antennae; many species have developed the power of flight.

Generally speaking, insects may be divided into three groups, depending upon the type of growth they have. In *ametabolous* forms (Series I), the young look like the adults except for being sexually immature. As sexual development takes place, some additional segments are added to the body – a process called anamorphosis. The adults are primarily flightless. Three small orders of insects are included here under the series *Ametabola.*

Certain insects, the *Paurometabola* (Series II), demonstrate gradual or incomplete metamorphosis. In these insects, the mouth parts of the young are the same as the

adults', and feeding habits are similar. The development of wing pads is external. Immature stages are termed nymphs, of which there may be several stages. There is no pupal stage, and most of the adults have power of flight. Three small orders and certain families within other orders are flightless. Mouth parts may be chewing or sucking, depending upon the order. Insects belonging to this series are thought to be less specialized than the forms that go through complete metamorphosis; nonetheless, they are highly developed and constitute some of the most important insects from an economic standpoint.

Holometabola (Series III) go through complete metamorphosis, including egg, larvae, pupae, and adult stages of development. With the exception of a few specialized forms, adults have wings. Larvae may or may not have legs; development of wing pads is internal; mouth parts of young frequently differ from adults' (i.e., chewing in larvae and piercing-sucking as adults), which enables the insects to utilize more sources of food. Wings, in general, are more highly modified than in the insects with gradual metamorphosis. The largest orders of insects (in number of species) occur in this series.

Series I – *Ametabola (Apterygota,* **anamorphosis)**

Order *Protura* **(proturans)**

Order *Thysanura* **(bristle tails)**

Family *Machilidae*

Family *Lepismidae* (silver fishes, fire brats)

Family *Campodeidae* (campodeids)

Family *Projapygidae*

Family *Japygidae* (japygids)

Order *Collembola* **(spring tails)**

Family *Ephemeridae* (burrowing mayflies)

Family *Heptageniidae* (stream mayflies)

Family *Baetidae* (small mayflies)

Order *Odonata* **(dragonflies and damselflies)**

Family *Poduridae*

Family *Entomobryidae*

Family *Neelidae*

Family *Smynthuridae*

Series II – *Paurometabola* (incomplete metamorphosis)

Order *Ephemeroptera* (mayflies)

Family *Gomphidae* (club tails)

Family *Aeshnidae* (darners)

Family *Cordulegastridae* (biddies)

Family *Macromiidae* (belted skimmers and river skimmers)

Family *Cordulidae* (green-eyed skimmers)

Family *Libellulidae* (common skimmers)

Family *Agrionidae* (broad-winged damselflies)

Family *Coenagrionidae* (narrow-winged damselflies)

Order *Plecoptera* (stone flies)

Family *Pteronarcidae* (giant stone flies)

Family *Taeniopterygidae* (winter stone flies)

Family *Nemouridae* (spring stone flies)

Family *Capniidae* (small winter stone flies)

Family *Perilidae* (common stone flies)

Order *Orthoptera* (grasshoppers, katydids, crickets, cockroaches, walkingsticks, and mantids): This group of insects is so diverse in morphology and habits that it is difficult to cite specific characteristics. Frequently the group listed here is broken down into several suborders or even divided into four or five separate orders. All species have mandibulate

(chewing) mouth parts; most are plant eaters; some are very destructive to vegetation; a few are predaceous. *Orthoptera* may be winged or wingless in the adult stage. Front wings generally are long and narrow, and frequently thickened; hind wings are broad and membranous, and, when the insect is at rest, usually folded fanwise beneath the front wings. Katydids and crickets are the major contributors to nature's orchestra during the long summer evenings.

Many species within this order are of considerable importance with respect to the vegetation in prairies. The following families are found with reasonable frequency:

Family *Tetrigidae* (pygmy grasshoppers)

Family *Acrididae* (short-horned grasshoppers): To this family belong most of the grasshoppers that are found in meadows, along paths, and along roadsides from the middle of summer until late fall. Their antennae are usually shorter than their bodies; auditory organs are located on the sides of the first abdominal segments; tarsi (feet) are three-segmented; and ovipositors are short and stout. Activity is typically confined to about 5 months during the warmest period of the year. In most species oviposition occurs in the late summer or early fall. Winter is passed in the egg stage, in diapause. Development is resumed with rising temperatures in the spring. The eggs hatch from May to July, nymphs mature during midsummer, and mating is followed by oviposition in the fall. In some species, nymphs overwinter and become adults the following spring, thus requiring one year to complete the life cycle. The following species are considered the most common, and are potentially damaging to plants in this area: *Melanoplus mexicanus, Melanoplus femur-rubon* (DeGeer), *Melanoplus packardii* (Scudder), *Melanoplus bivatatus* (Say), *Melanoplus differentalis* (Thomas), and *Schisterocera americana* (Scudder). The amount of loss caused by grasshoppers depends largely on the species present, as each species displays a certain selectivity in their food-plant preferences. The degree of selectivity apparently is inherent in the grasshopper species, but the expression of selectivity is determined by the habitat. Generally speaking, three feeding categories are recognized: species that feed on grasses; those that feed on broad-leafed plants; and those that feed on both grasses and broad-leafed plants. Preferences, however, may change with plant maturity during the growing season. Damage caused by grasshoppers goes beyond the actual consumption of foliage. They cut grass stems and blades, and eat a portion of them. They eat closer to the ground than livestock, and frequently destroy the growing tips of

grasses. They sometimes cut off the seed stalks, reducing seed production. Soil erosion can follow denudation by heavy populations of grasshoppers. The actual amount of damage caused by grasshoppers has been estimated by a number of workers, but accurate data simply are not available at this time.

Family *Tettigoniidae* (long-horn grasshoppers)

Family *Gryillidae* (crickets): These insects resemble long-horned grasshoppers; however, tarsi are three-segmented, ovipositors needlelike or cylindrical, and front wings bent down sharply at the sides of the body. The field cricket, *Acheta assimilis,* is widely distributed. The tree cricket, *Oechanthus niveus,* is perhaps the best known, and is common on the foliage of trees and shrubs. Songs of tree crickets are heard commonly throughout the night during summer and fall. Mole crickets *(Gryllotalpa* spp.) have the four tibia adapted for digging. Usually the mole crickets do not occur in sufficient numbers to be pestiferous in this area.

Family *Blattidae* (cockroaches and wood roaches)

Family *Mantidae* (mantids)

Family *Phasmidae* (walking sticks)

Order *Isoptera* (termites-white ants)

Order *Dermaptera* (earwigs)

Family *Foriculidae*

Order *Pscoptera* (pscopids)

Order *Thysanaptera* (thrips)

Order *Mallophaga* (chewing lice, bird lice): These are small, flattened, wingless ectoparasites found on birds and mammals, especially birds. The head of a louse is generally large and flattened, and eyes are degenerate. *Mallophaga* are host-specific. Eggs are glued to hairs and feathers of the host. Nymphs occupy the same area of the host as the adults. Of the six families, two are associated with mammals. Members of the family *Trichodectidae* are found only upon native mammals. At times, *Trichodectes canis* is extremely abundant upon coyotes.

Order *Anoplura* (sucking lice): Normally these insects are ectoparasites found on mammals. Mouth parts formed for piercing and sucking are retractable into a capsule within the head. The head is narrow, usually cone-shaped anteriorly. Eyes are vestigial or wanting. Although these insects have had an enormous influence in human history, they are most likely of academic importance in the region in question. Of the four families known to occur in the U.S., only two *(Haematopinidae* and *Pediculidae)* occur in the study areas. If the black-tailed prairie dog were reintroduced, care probably should be taken to ensure that the specimens transplanted were free of lice before being released in the area. This suggestion is offered because these lice are thought to be important with respect to the epizootics that periodically decimate prairie dog colonies.

Order *Homoptera* (aphids, leaf hoppers, cicadas, and others)

Family *Cicadidae* (cicadas or "locusts")

Family *Ceropidae* (froghoppers and spittlebugs)

Family *Membracidae* (treehoppers)

Family *Cicadellidae* (leafhoppers)

Family *Fulgoridae* (lanternfly)

Family *Chermidae* (jumping plant lice)

Family *Aphididae* (plant lice)

Family *Phylloxeridae* (aphids)

Family *Aleyrodidae* (white flies)

Family *Coccidae* (scale insects, bark lice, mealy bugs, and others): These insects are unusual because they are so modified in appearance that they do not resemble ordinary insects, with the exception of the adult males, which are winged. They are usually small and inconspicuous, and most of them are found on the leaves and stems of fruits. The majority of the species remain immotile, at least for part of their life cycle, and they may be transported alive for long distances on nursery stock. *Dactylopius coccus,* a scale insect, has been important in the production of aneline dyes. This is one of the principal cochineal insects, which occurs on prickly pear (*Opuntia* spp.) in the study areas, and is one of the insects important in biologically controlling this plant.

Homoptera are among the most numerous insects in the rangeland ecosystem, and are unique among the major orders in that they are all plant feeders, many with a high degree of host specificity. Their greatest damage is the removal of sap, composed mostly of water and low concentrations of various nutrients. In addition, some *Homoptera* (leaf hoppers and aphids) are vectors of plant viruses. The salivary secretion injected into the plant in the normal feeding process may cause an abnormal plant response. A few species (cicadas and some leaf hoppers) cause damage with their ovipositors during the process of oviposition. Most *Homoptera* pass the winter as eggs imbedded in plant tissue, and a few overwinter as adults.

Numerous species of aphids are commonplace in native grassland vegetation, but seldom in the abundance observed on cultivated plants. The green bug, *Chizaphis graminum,* feeds on native grasses, and sometimes causes substantial damage to cultivated grains. The hosts of most grassland species are forbs and shrubs rather than grasses.

Order *Hemiptera* (true bugs): Members of this order almost always have two pairs of wings. The basal half of anterior wings is thickened, and the posterior portion is membranous. Mouth parts are of the piercing-sucking type, arising from the anterior portion of the head. The body is usually broad and flattened dorsoventrally.

Hemiptera and *Homoptera* are frequently combined in the same order, and then relegated to separate suborders. As with the *Homoptera,* representatives of certain *Hemiptera* families are important in the grassland biome, particularly because of their effect upon the production of grasses and forbes. The most important families are *Miridae, Tingididae, Lygaedae,* and *Pentatomidae.* However, certain species are important in the control of plants that are considered undesirables, such as the prickly pear. Hunter et al. (1912) cited more than 300 insect species associated with the prickly pear. Ninety-two of these insects were considered by Hunter to be injurious to the plant. Investigators considered *Chelinidea* spp. (*Coridae*) the principal insect injurious to *Opuntia.* The feeding of the cactus bug is thought to be associated with a fungus, *Gloeosporium lanatum,* which causes a great deal of damage to the cactus.

The order *Hemiptera* generally is divided into 33 families; 29 of these are encountered within the study areas, as follows:

Family *Scutelleridae* (shield-backed bugs)

Family *Cydnidae* (negro bugs and burrowing bugs)

Family *Pentatomidae* (stink bugs)

Family *Coreidae* (squash bugs)

Family *Aradidae* (flat bugs)

Family *Neididae* (stilt bugs)

Family *Lygaeidae* (cinch bugs)

Family *Pyrrhocoridae* (cotton stainers)

Family *Tingitidae* (lace bugs)

Family *Enicocephalidae* (unique-headed bugs)

Family *Phymatidae* (ambush bugs)

Family *Reduviidae* (assassin bugs)

Family *Hebridae*

Family *Mesoveliidae*

Family *Nabidae* (damsel bugs)

Family *Cimicidae* (bed bugs)

Family *Anthorcoridae* (flower bugs)

Family *Miridae* (plant bugs)

Family *Isometopidae* (water bugs)

Family *Dipsocoridae* (jumping ground bugs)

Family *Schizopteridae*

Family *Hydrometridae* (water measurers)

Family *Gerridae* (water striders)

Family *Veliidae* (broad-shouldered water spiders)

Family *Salidae* (shore bugs)

Family *Notonectidae* (back swimmers)

Family *Naucoridae* (creeping water bugs)

Family *Nepidae* (water scorpions)

Family *Belostomatidae* (giant water bugs)

Family *Gelastocoridae* (toad-shaped bugs)

Family *Ochteridae* (ochterids)

Family *Corixidae* (water boatmen)

Like other large orders, *Hemiptera* are widely distributed, and differ considerably in both habitat and feeding habits. Some are aquatic *(Corixidae, Belostomatidae),* but most are terrestrial. The majority are plant feeders, but a few are predaceous, such as Nabidae and Reduviidae. Some, like members of the genus *Geocoris* (family *Lygaeidae*), combine both predaceous and plant-feeding habits. Still others are hematophagous, and suck blood from warm-blooded animals (*Cimicidae* and certain of the *Reduviidae*).

Within the family *Miridae,* the genera *Labops* and *Irbisia* commonly are referred to as black grass bugs, and recently have been recognized as major pests in restricted areas in most of the western states. As many as 8,000 to 10,000 of these bugs may be found in a single clump of grass. When these insects are controlled, damaged plants recover (if adequate moisture is available). The meadow plant bug *(Leptopterna dolabrate)* occurs in high densities in roadside bluegrass in Missouri; 180 specimens per 100 insect net sweeps have been reported.

Some members of the family *Lygaeidae* are predaceous, but most are plant feeders. The cinch bug *(Blissus leucopterus)* is one of the most representative and important species. Adults and nymphs of the cinch bug feed on both cultivated and range grasses. This insect is widely known for its extensive damage to small grains, corn, and tall grasses. Whole fields may be destroyed. This insect is native to the prairie states, and undoubtedly does considerable feeding on rangeland and pastureland even in years when the population fails to cause significant damage to cultivated crops. Lavigne et al. (1972) found that next to leafhoppers, cinch bugs are the most abundant sucking insects on the prairie.

The false cinch bugs (*Nysius* spp.) have similar habits, but usually are more westerly in distribution than cinch bugs. They are pests on range grasses, and extremely large populations sometimes develop on cultivated croplands. They are particularly abundant in buffalo grass and in blue grama pastures in the shortgrass areas.

The family *Pentatomidae* is represented by bugs that are phytophagous, predaceous, or both. The phytophagous stink bugs commonly feed more on the stems or fruits of broad-leafed plants than on grasses. They are seldom found in large numbers on range vegetation, and the impact is probably minimal. The highly-colored Harlequin bug *(Murgantia histrionica),* often a serious pest of cultivated cruciferous plants, is occasionally found feeding on certain range forbs.

Members of the family *Tingitidae* (lace bugs) are rather small, and derive their common name from the lace-like pattern on the front wings and the upper surface of the head and thorax of the adults. Lace bugs cause injury to plants during feeding. First, tiny yellow or chlorotic spots appear on the leaves; after continued feeding, leaves turn brown and fall off. Three or four species are known to be important in the shortgrass prairie, but little or no information is available with regards to the tallgrass prairie.

Series III – *Holometabola* (complete metamorphosis)

Order *Neuroptera* (nerve-winged insects)

Family *Sialidae* (alderflies)

Family *Corydalidae* (Dobson flies, fish flies, and helgrammites)

Family *Mantispidae* (mantid flies)

Family *Hemerodiidae* (brown lacewings)

Family *Crysopidae* (common lacewings): These insects are quite common on grass, forbs, and the foliage of trees. Most of them are greenish in color with golden or copper-colored eyes. The eggs are usually layed on foliage, and each egg is layed at the end of a minute stalk. The larvae are predaceous, and are important in the biological control of aphids.

Family *Myrmeleontidae* (ant lions, doodlebugs)

Family *Ascalaphidae* (owl flies)

Order *Coleoptera* **(beetles and weevils):** The beetles constitute the largest order of insects. Their size varies from about 1 mm. up to 70 mm. in length. Mouth parts are mandibulate both in adults and larvae. Beetles have four wings, the front pair modified into a chitenous elytra and the hind pair membranous and much larger. When the beetle is at rest, the hind wings are folded beneath the elytra.

Beetles are found in almost every imaginable habitat. They may be phytophagous, scavenging, predaceous, or parasitic. The overall importance of *Coleoptera* in the grassland biome seems small when compared with that of the species in other orders. The most important *Coleoptera* species is the white grub, which can be highly destructive in localized areas; however, the role of many other species is much more subtle and not yet clearly delineated. The darkling beetles are among the most familiar beetles on the range. They are said to feed largely on vegetable matter, both dead and alive, but their impact is not known. The phytophagous species that sometimes cause damage to range grasses include white grubs *(Scarabaeidae),* wire worms *(Elateridae),* leaf beetles *(Chrysomelidae)* – associated more with the forbs than with grasses – snout beetles *(Curculionidae),* and blister beetles *(Meloidae).*

The order *Coleoptera* is usually divided into two suborders, *Adephaga* (members mostly predaceous) and *Polyphaga* (members feed on a variety of substances); the latter suborder contains the bulk of the specimens. Families in the order *Coleoptera* include the following:

Family *Cicindelidae* (tiger beetles)
Family *Carabidae* (ground beetles)
Family *Omophronidae* (round sand beetles)
Family *Haliplidae* (crawling water beetles)
Family *Dytiscidae* (predaceous diving beetles)
Family *Gyrinidae* (whirligig beetles)
Family *Platypsyllidae* (beaver parasites)
Family *Brathinidae*
Family *Leptinidae* (mammal-nest beetles)
Family *Silphidae* (carrion beetles)
Family *Staphylinidae* (rove beetles)
Family *Pselaphidae*
Family *Ptiliidae* (feather-winged beetles)
Family *Scaphidiidae* (shining fungus beetles)
Family *Histeridae* (hister beetles)
Family *Lycidae* (net-winged beetles)
Family *Lampyridae* (firefly beetles)

Family *Cantharidae* (soldier beetles)
Family *Melyridae* (soft-winged flower beetles)
Family *Cleridae* (checkered beetles)
Family *Oedemeridae*
Family *Mordellidae* (tumbling flower beetles)
Family *Rhipiphoridae*
Family *Meloidae* (blister beetles)
Family *Othniidae*
Family *Pythidae* (pythenid bark beetles)
Family *Pyrochroidae* (fire-colored beetles)
Family *Euglenidae*
Family *Rhipiceridae* (cedar beetles)
Family *Elateridae* (click beetles)
Family *Buprestidae* (metallic wood borers)
Family *Psephenidae* (water pennies)
Family *Dryopidae*
Family *Helmidae*
Family *Heteroceridae* (variegated mud-loving beetles)
Family *Dermestidae* (skin beetles)
Family *Byrrhidae* (pill beetles)
Family *Ostomatidae* (bark-gnawing beetles)
Family *Nitidulidae* (sap-feeding beetles)
Family *Rhizophagidae*
Family *Cucujidae* (cucujids)
Family *Erotylidae* (erotylids)
Family *Mycetophagidae* (hairy fungus beetles)
Family *Endomychidae* (handsome fungi beetles)
Family *Phalacridae* (shining flower beetles)
Family *Coccinellidae* (lady beetles)
Family *Alleculidae* (comb-clawed bark beetles)
Family *Tenebrionidae* (darkling beetles)
Family *Lagriidae* (lagriid bark beetles)
Family *Melandryidae* (melandryid bark beetles)
Family *Anobiidae* (death watch beetles)
Family *Bostrichidae* (powder post beetles)
Family *Lyctidae*
Family *Scarabaeidae* (lamellicon beetles)
Family *Trogidae* (skin beetles)
Family *Lucanidae* (stag beetles)
Family *Passalidae*
Family *Cerambycidae* (long-horned beetles)
Family *Chrysomelidae* (leaf beetles)
Family *Brucidae* (bean weevils)

Family *Brentidae* (primitive weevils)
Family *Curculionidae* (typical snout beetles)
Family *Scolytidae* (engraver beetles)

Time and space do not permit dealing at the species level with this huge order. A few examples have been selected to indicate the type of damage that can be caused by beetles. The adults of the white grubs (*Phyllophaga* spp.) are the familiar June beetles that are attracted to lights at night in the late spring and summer. The larvae are white and shaped like "C"s or "U"s. About 200 species are known from throughout the U.S., and most require 3 years to complete their life cycles. Damage by white grubs or their larvae can result in complete stands of bermuda and/or other grasses being completely destroyed. Densities of white grubs have been reported in excess of 200 per square meter.

Little is known about the *Meloidae,* or blister beetles. They are fairly conspicuous in the grassland, and at times specimens are colorful. Adults usually congregate on the blossoms of flowering forbs, and most species apparently feed on the blossoms and pollen, and only incidentally upon leaves. It is difficult to postulate what effect they may have on the host plant, but they probably reduce seed production while acting as cross-pollinators. In certain instances, they have beneficial effects, because beetle larvae are predaceous upon grasshopper eggs. The family *Tenebrionidae* (darkling beetles) are general feeders. They have been reported as scavengers on decaying vegetation and as consumers of fungi, seeds, roots, tubers, and flowers. The larvae of some forms are presumed to be root feeders that can potentially reduce below-the-ground plant biomass in certain types of range. No detailed studies of the ecology of darkling beetles on rangelands have been published.

The weevils belong to the family *Curculionidae.* Reports of damage to range vegetation by weevils are almost nonexistent – in distinct contrast to the information about weevil effects on certain commercial crops. At the IBP grassland biome site in 1970, curculionidids composed the third highest biomass (Blocker and Reed 1971). Again, the effects of these beetles on native plants are not clearly understood.

Wireworms of the family *Elateridae* cause extensive damage to cultivated crops, including many of the grass family. Unquestionably, they also have a pronounced (but as yet undetermined) impact on range vegetation in their native habitat. Recent studies have found a certain species abundant in a particular type of grassland habitat, but the role in the grassland ecosystem has not been studied.

The leaf beetles, or *Chrysomelidae,* are common on forbs and shrubs, but absent from grasses. Broad-leafed plants such as sunflowers are the victims of heavy attacks by these insects. The importance of their overall effects on the grassland biome is unknown.

The seed beetles, or *Bruchidae,* have heads that elongate into short, broad snouts. The larvae feed chiefly on the seeds of leguminous plants, and have a considerable-to-high degree of host-specificity. Many species attack the seeds of wild legumes, but their biology and ecology is not well known.

Order *Mecoptera* (scorpion flies)

Order *Trichoptera* (caddisflies)

Order *Lepidoptera* (moths and butterflies)

Family *Papilionidae* (swallowtail butterflies)
Family *Pieridae*
Family *Danaidae* (milkweed butterflies)
Family *Satyridae* (meadow brown butterflies)
Family *Nymphalidae* (brushfooted butterflies)
Family *Libytheidae* (long-beaks)
Family *Lycaenidae* (gossamer-winged butterflies)
Family *Hesperiidae* (skippers)
Family *Sphingidae* (sphinx moths)
Family *Saturniidae* (giant silkworms)
Family *Arctiidae* (tiger moths)
Family *Noctuidae* (owlet moths)
Family *Notodontidae* (prominents)
Family *Lymantriidae* (tussock moths)
Family *Lasiocampidae* (tent caterpillars)
Family *Geometridae* (measuring worms)
Family *Epiplemidae*
Family *Lacosomidae*
Family *Psychidae* (bagworm moths)
Family *Limacodidae* (slug-caterpillar moths)
Family *Megalopygidae* (funnel-moths)
Family *Pyralidae* (pyralids): The *Pyralidae,* or sod webworms, have caterpillars that are whitish to pale yellow. They are found throughout the U.S. and the larvae damage pastures and meadows so severely that forage yields and carrying capacities are greatly reduced. Three generations per year are typical for common species of sod webworms. They overwinter as larvae, and pupate in the spring. Adult moths

appear in May or June, and females oviposit either while in flight or at rest. Adults have small, slender bodies and prominent heads. Extended hot and dry periods during the summer months reduce the numbers of these moths; greater numbers appear during years of well-distributed rainfall.

Family *Pterophoridae* (plume moths)
Family *Orneodidae* (many-plumed moths)
Family *Cosmopterygidae*
Family *Gelechiidae*
Family *Stenomidae*
Family *Aegeriidae* (clear-winged moths)
Family *Eucosmidae*
Family *Tortricidae* (leaf rollers)
Family *Yponomeutidae* (beautiful mining moths)
Family *Tischeriidae*
Family *Gracilariidae*
Family *Scythrididae*
Family *Lyonetiidae*
Family *Acrolophidae*
Family *Tineidae*
Family *Cossidae* (carpenter moths)
Family *Prodoxidae* (yucca moths and others)
Family *Hepialidae* (swifts)
Family *Saturniidae*: This family includes the range caterpillar, *Hemileuca oliviae,* which is spectacular because of its size and destructiveness to range grass. Although this species is not known in the study areas, its rather broad distribution and its destructive habits are sufficient to at least mention it.

Family *Noctuidae* (cutworms and armyworms): These caterpillars cause their most noticeable and widespread damage to cereal and forage crops. Large cultivated tracts in monoculture crop production provide an abundance of food for these and other native insect pests. Walkden (1943) identified 24 species of cutworms and armyworms on pasture grasses in the vicinity of Manhattan, Kansas, but only seven of these species inflicted 98 percent of the damage, including the dingy cutworm (*Feltia subgothica*), the variegated cutworm (*Peridroma saucia*), the bronzed cutworm (*Nephelodes minians*), the army cutworm (*Euxoa auxiliaris*), the armyworm (*Pseudaletia unipunctea*), and the clayback cutworm (*Agrotis gladiaria*). Based on feeding behavior, cutworms and armyworms fall into four principal groups: solitary, surface cutworms; climbing cutworms; army cutworms, which crawl along the ground and, after consuming all vegetation, move on to

adjacent vegetation (this group usually occurs in large numbers); and subterranean cutworms. Caterpillars of the family *Noctuidae* are commonly referred to as the wheat head armyworms, and feed on seeds of a variety of grasses. The impact on seed production is usually minimal on range land, but sometimes limits the production of sand bluestem (*Andropogon halli*). Eggs are layed in the seed heads and the larvae of all ages feed there, beginning when the inflorescence emerges from the boot and continuing as long as the seeds are in the dough stage.

Order *Siphonaptera* **(fleas):** Fleas are small, wingless, laterally compressed ectoparasites that as adults feed on the blood of mammals and birds. The larvae are free-living either in the nests of hosts or in other areas that they habituate. Probably four to five families would be represented in the study areas.

There are no fleas in the region that would parasitize man under normal circumstances, and none that are known to be proven disease-transmitters. However, there are indications that *Opisocrostis hirsutus* of the family *Ceratophyllidae* is involved in the transmission of plague, and in the event that the black-tailed prairie dog is reintroduced, efforts should be made to ensure that this flea is not present. Species of the six following families of fleas are found in the study areas: *Hystrecopsyllidae, Leptopsyllidae, Ceratophyllidae, Ischnopsyllidae, Pulicidae,* and *Vermipsyllidae.*

Order *Hymenoptera* **(bees, hornets, wasps):** *Hymenoptera* is a large order of insects, with close to 100,000 known species in the world. It is thought to be the most beneficial order, inasmuch as it contains many parasites and predators that attack other insects, as well as the most important insect pollinators of plants – the bees. However, some destructive forms are included, such as certain species of ants and sawflies.

The members of this order may be characterized as follows: two pairs of membranous wings usually present, hind pair smaller, veination specialized and more or less reduced; mouth parts mandibulate or adapted for both chewing and sucking; abdomen of female usually provided with a saw, piercing organ, or sting. The ants, bees, and wasps are the best known members of the order.

Hymenoptera is divided into two suborders: the *Symphyta,* which comprise the sawflies and horntails; and the *Apocrita,* including wasps, bees, ichneumonid flies, and other species. In species of the suborder *Symphyta,* the abdomen is broadly joined to the thorax, and the trochanter has two

segments. In *Apocrita* species the first segment of the abdomen, known as the propodeum, is fused with the thorax, and the second segment is conspicuously constricted into a slender petiol, producing a characteristic wasp-waisted appearance. The following families are included in the order *Hymenoptera:*

Family *Xyelidae* (xyelid sawflies)
Family *Pamphiliidae* (web-spinning and leaf-rolling sawflies)
Family *Cephidae* (stem sawflies)
Family *Siricidae* (horn-tails)
Family *Crabronidae* (American sawfly and others)
Family *Tenthredinidae* (typical sawflies)
Family *Braconidae* (braconids)
Family *Ichneumonidae* (ichneumon wasps)
Family *Stephanidae*
Family *Gasteruptionidae*
Family *Roproniidae*
Family *Heloridae*
Family *Vanhorniidae*
Family *Diapriidae*
Family *Serphidae*
Family *Callicerotidae*
Family *Ceraphronidae*
Family *Scelionidae*
Family *Platygasteridae*
Family *Cynipidae* (cynipids)
Family *Cholcididae* (chalcid flies)
Family *Eurytomidae* (wheat jointworms, wheat straw-worms, and others
Family *Encyrtidae*
Family *Signiphoridae*
Family *Pteromalidae*
Family *Aphelinidae*
Family *Eulophidae*
Family *Evaniidae* (ensign wasps)
Family *Psammocharidae* (spider wasps)
Family *Chrysididae* (cuckoo-wasps)
Family *Sapygidae*
Family *Tiphiidae*
Family *Mutillidae* (velvet ants)
Family *Scoliidae* (scoliids)
Family *Formicidae* (ants)
Family *Bethylidae*
Family *Rhopalosomidae*

Family *Vespidae* (hornets, paper wasps)
Family *Ampulicidae*
Family *Dryinidae*
Family *Sphecidae* (typical sphecid wasps)
Family *Hylaeidae* (bifid-tongued bees)
Family *Andrenidae* (andrenids)
Family *Megachilidae* (leaf-cutter bees)
Family *Bombidae* (bumblebees)
Family *Xylocopidae* (carpenter bees)
Family *Apidae* (honey bees): Our introduced honeymaker, *Apis mellifera,* is part of this family. Colonies of this domesticated bee are feral in wooded areas.

As mentioned earlier, *Hymenoptera* are considered highly beneficial insects, although some through their feeding habits are destructive. Certain of these forms are important in the grassland biome, and are discussed briefly.

The harvester ants, belonging to the family *Formicidae,* probably rank next to the grasshoppers as having the greatest impact of any insect in the rangeland ecosystem. Conical mounds of sand and pebbles as high as 30 cm. surrounded by large denuded areas up to 8 m. in diameter give evidence of the presence of this insect. The genus is widely dispersed throughout the country; however, the species of concern in the study areas is the red harvester ant (*Pogonomyrmex barbatus*). These harvester ants reportedly have caused complete failure in experimental range seedings by gathering seed and cutting off young emerging plants. Despite the large number of seeds collected by the harvester ants, there is some question as to their effect on stands of grasses, especially perennial grasses that produce primarily by means of stolons. And on the positive side, these ants may be dispersal agents for grasses that produce large seeds.

Grass stem-boring *Hymenoptera* belong to the families *Eurytomidae* and *Cephidae.* Although a number of *Hymenoptera* develop in the stems of range grasses, ranchers and range managers do not appear concerned, and only an occasional economic entomologist has shown interest. Consequently little is known of the impact of these insects on the well-being of the grassland biome. Two genera of particular importance are the wheat joint worms, *Harmolita* spp., and the wheat stem sawfly, *Cephufcinctus.* Members of these two genera are well known as significant pests of cereal grains, but they were initially, and remain, parasites of the native grasses. They commonly infest such grass genera as *Poa, Festuca, Bromus,* and *Agropyron.*

Much has been said of the pollinating efforts of bees. The well-known honey bee (*Apidae*) is not native to the New World, but feral populations are

widely dispersed throughout the woodlands, and are of course of considerable importance in pollinating plants. Two families, the *Andrenidae* and the *Megachilidae,* are probably of greatest importance insofar as native vegetation is concerned. These are solitary bees; in other words, they do not have social systems of domestic bees. Genera of importance within these two families are *Andrena, Halictus, Anthophora, Megachile, Osmia, Anthidium,* and *Coelioxys.*

Many of the wasps belonging to the families *Sphecidae* and *Vespidae* are well known for their predaceous habits on other insects. However, forms like the *Scolidae,* which are parasitic upon white grubs, and the *Tiphidae* are parasites of enormous importance.

Order *Diptera* (flies and mosquitoes): *Diptera* is one of the four largest orders of insects, and consists of about 90,000 species on a world-wide basis. In many respects, this is the most important group of insects with which people have to contend. Many species, such as mosquitoes, black flies, and others suck the blood of humans and other animals, and are therefore important in the transmission of diseases. The larvae of screw-worm flies, spot flies, and other forms attack animals; others, such as fruit flies, are simply pestiferous as larvae.

Flies are not harmful. The larvae of some species aid in the decomposition of organic matter; others are parasitic on other insects, especially members of the family *Tachinidae;* some are predators, such as the robber flies (*Asilidae*); and still others are important in the pollinating of plants. Members of the family *Syrphidae* and *Bombyliidae* are important in pollination. The following families are included in the order *Diptera:*

Family *Tipulidae* (typical crane flies)
Family *Anisopodidae*
Family *Blephariceridae* (net-winged midges)
Family *Simuliidae* (black flies)
Family *Thaumaleidae*
Family *Chironomidae* (midges)
Family *Ceratopogonidae* (biting midges)
Family *Psycholidae* (moth flies)
Family *Dixidae* (dixa midges)
Family *Culicidae* (mosquitoes)
Family *Cecidomyidae* (gall midges)
Family *Sciaridae* (dark-winged fungus gnats)
Family *Mycetophilidae* (fungus gnats)
Family *Bibionidae* (March flies)

Family *Scatopsidae* (minute black scavengers)
Family *Stratiomyidae* (soldier flies)
Family *Tabanidae* (horse flies)
Family *Rhagionidae* (snipe flies)
Family *Scenopinidae* (window flies)
Family *Asilidae* (assassin or robber flies)
Family *Therevidae* (stiletto flies)
Family *Bombyliidae* (bee flies)
Family *Memestrinidae*
Family *Empidae* (dance flies)
Family *Dolichopidae* (long-headed or long-legged flies)
Family *Phoridae* (hump-backed flies)
Family *Platypezidae* (flat-footed flies)
Family *Pipunculidae* (big-headed flies)
Family *Syrphidae* (flower flies)
Family *Conopidae* (thick-headed flies)
Family *Pyrgotidæ*
Family *Otitidae* (pictured-winged flies)
Family *Trupaneidae* (fruit flies)
Family *Ropalomeridae*
Family *Calobatidae* (stilt-legged flies)
Family *Micropezidae*
Family *Neriidae*
Family *Sepsidae*
Family *Lauxaniidae*
Family *Periscelidae*
Family *Drosophilidae* (small fruit flies)
Family *Agromyzidae* (leaf miners)
Family *Chloropidae* (frit flies)
Family *Ephydridae* (shore flies)
Family *Clusiidae*
Family *Tetanoceridae* (marsh flies)
Family *Helomyzidae*
Family *Dryomyzidae*
Family *Muscidae* (house flies and smaller pests)
Family *Sarcophagidae* (flesh flies)
Family *Cuterebridae* (robust bot flies)
Family *Gasterophilidae* (horse bot flies)
Family *Oestridae* (bot flies)
Family *Tachinidae* (tachinids)
Family *Hippoboscidae* (bird parasite flies)
Family *Nycteribiidae*
Family *Sterblidae* (bat flies)

Members of the family *Culicidae*, mosquitoes, are known to almost everyone. In the grassland biome generally there are two genera that predominate, *Aedes* and *Psorophora*. In prairie not modified extensively by man, mosquito populations are not dense. However, cultural practices can completely change the natural situation.

Adult *Diptera* have mouth parts of the lapping or sucking type. The larvae generally have chewing-type mouths, although they may be highly modified; therefore, the young exhibit a great diversity of habits. In some families, such as *Culicidae* (mosquitoes), *Simuliidae* (black flies), *Tabanidae* (horse flies), and others, the adults are hematophagous and are vectors of serious human and animal diseases. Robber flies (*Asilidae*) are predaceous on other insects; the larvae of some syrphid flies (*Syrphidae*) are predaceous on aphids and tachinids (*Tachinidae*), and are parasitic on other insects; the bot flies (*Oestridae*), warble flies *(Hypodermatidae),* and horse bot flies (*Gasterophilidae*) develop in the flesh of sheep, cattle, and horses. The fruit flies (*Trypteridae*), gall midges (*Cecidomyiidae*), leaf miners *(Agromyzidae),* and frit flies *(Chloropidae)* include a great many of the phytophagous species.

Two families, the *Chloropidae* and *Cecidomyiidae,* account for most of the dipterans' damage to range grasses. The chloropids, or frit flies, are a large group. Their abundance and type of injury on grassland indicate that they are of greater economic importance than has been documented. Some feed on vegetative tissue (stems and buds), while others feed on the unemergent seed heads. An indication of the abundance and diversity of chloropids in grasslands comes from work in Kansas. In systematic sampling, Wilbur and Sabrosky (1936) found 14 genera and 53 species in a prairie grassland plot. The flies apparently lay their eggs in the young shoots very early in the culm-elongation period. The maggots make their way to the embryonic inflorescence and feed on the developing seed. No evidence of their presence is obvious until the inflorescence begins to emerge from the boot, at which time the infested culms present a "witch's broom" appearance. The seed head never fully expands and few, if any, seeds are produced.

Like the chloropids, some maggots of the *Cecidomyiidae* family attack grass seeds, while others attack vegetative tissue. The sorghum midge *(Contarinia sorghicola)* is often a serious pest of cultivated grain sorghum, and the larvae are commonly found in Johnson grass seeds. Two other species of this family attack range grasses and appear to be host-specific; *Contarina wattsi* attacks little bluestem, and *Contarinia halli* attacks sand bluestem.

If bison are introduced into the study areas, they will have dipterans to contend with that their ancestors did not have. The horn fly has been

introduced from Europe, and most likely the face fly will soon be established in the area. The face fly, introduced into the United States approximately 15 to 20 years ago, will be at its western limit in the study areas.

At least 12 species of robber flies *(asilidae)* have been found to attack grasshoppers. These predators capture the grasshoppers and suck out the internal organs, casting off the empty shell. Lavigne and Pfadt (1966) have shown that these flies could theoretically account for the destruction of 11 to 15 percent of grasshoppers on eastern Wyoming rangeland. The predatory habits of 21 species of rangeland *Asilidae* occurring on the Pawnee grasslands in northeastern Colorado were studied by Rogers and Lavigne (1972).

Some mention of parasitic habits has been made earlier in this discussion. Three families of flies – *Sarcophagidae, Tachinidae, and Nemestrinidae* – contain numerous species that are important parasites of grasshoppers. Eggs or living larvae are deposited by the adult flies on the grasshoppers. Upon hatching, the larvae find their way inside the grasshopper where they develop, usually in the abdominal cavity. On attaining maturity, they leave the grasshopper and pupate in the soil. The grasshopper dies almost immediately afterwards. These parasites reduce feeding by grasshoppers and prevent reproduction.

While the field observations that appear in most of the literature make interesting reading, they seldom provide either the quantitative or qualitative data necessary to analyze the effect of parasites on insect populations. The extent of parasitism by *Diptera* was summarized by Lavigne and Pfadt (1966) for two grasshopper outbreak areas in shortgrass range in Wyoming. These data were collected during four seasons, 1959-1962, and revealed that the dipterous parasitism rate was less than 2 percent annually. On the other hand, York and Prescott (1952), working in Montana, found 15 species of grasshoppers parasitized at various levels by *Nemestrinids.* The highest rate of parasitism by these dipterans was 80 percent in females of *Metator pardalinus.* These data indicate that radical differences of effectiveness of parasites exist between different geographical areas.

LITERATURE CITED

FISHES

BLAIR, A.P.

1959 "Distribution of the Darters (Percidae, Etheostomatinae) of Northeastern Oklahoma." *Southwestern Naturalist,* vol. 4, no. 1, pp. 1-13.

CONSERVATION COMMITTEE, KANSAS ACADEMY OF SCIENCE

1973 "Rare, Endangered, and Extirpated Species in Kansas, I. Fishes." *Kansas Academy of Science Transactions,* vol. 76, no. 2, pp. 97-106.

CROSS, F.B.

1954 "Fishes of Cedar Creek and the South Fork of the Cottonwood River, Chase County, Kansas." *Kansas Academy of Science Transactions,* vol. 57, no. 3, pp. 303-314.

1967 *Handbook of Fishes of Kansas.* University of Kansas, Museum of Natural History miscellaneous publication no. 45.

CROSS, F.B., and M. BRAASCH

1968 "Qualitative Changes in the Fish-Fauna of the Upper Neosho River System, 1952-1967." *Kansas Academy of Science Transactions*, vol. 71, no. 3, pp. 350-360.

METCALF, A.L.

1959 *Fishes of Chautauqua, Cowley, and Elk Counties, Kansas.* University of Kansas, Museum of Natural History publication, vol. 11, no. 6.

1966 *Fishes of the Kansas River System in Relation to Zoogeography of the Great Plains.* University of Kansas, Museum of Natural History publication, vol. 17.

MILLER, R.J., and H.W. ROBISON

1973 *The Fishes of Oklahoma.* Stillwater: Oklahoma State University Press.

MINCKLEY, W.L., and F.B. CROSS

1959 "Distribution, Habitat, and Abundance of the Topeka Shiner *(Notropis topeka)* (Gilbert) in Kansas." *American Midland Naturalist,* vol. 61, no. 1, pp. 210-217.

PFLIEGER, W.L.
1971 *A Distributional Study of Missouri Fishes.* University of Kansas, Museum of Natural History publication, vol. 20, no. 3.

UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF SPORT FISHERIES AND WILDLIFE
1973 *Threatened Wildlife of the United States.* Resource publication 114. Washington, D.C.: U.S. Government Printing Office.

REPTILES AND AMPHIBIANS

BREUKELMAN, J., and R.F. CLARKE
1951 "A Revised List of Amphibia and Reptiles of Chase and Lyon Counties, Kansas." *Kansas Academy of Science Transactions,* vol. 54, no. 4, pp. 542-545.

CLARKE, R., J. BREUKELMAN, and T. ANDREWS
1958 "An Annotated Check List of the Vertebrates of Lyon County, Kansas." *Kansas Academy of Science Transactions,* vol. 61, no. 2, pp. 165-194.

COLLINS, J.T.
1974 *Amphibians and Reptiles in Kansas.* University of Kansas, Museum of Natural History public education series no. 1.

FITCH, H.
1958 *Home Ranges, Territories, and Seasonal Movements of Vertebrates of the Natural History Reservation.* University of Kansas, Museum of Natural History publication, vol. 11, no. 3.

1960 *Autecology of the Copperhead.* University of Kansas, Museum of Natural History publication, vol. 13, no. 4.

GIER, H.T.
1967 "Vertebrates of the Flint Hills." *Kansas Academy of Science Transactions,* vol. 70, no. 1, pp. 51-59.

GREEN, H., and G. OLIVER
1965 "Notes on the Natural History of the Western Massasauga." *Herpetologica,* vol. 21, no. 3, pp. 225-228.

KLAUBER, L.

1972 *Rattlesnakes.* 2 vols. 2nd ed. University of California Press.

MINTON, S., and M. MINTON

1969 *Venomous Reptiles.* New York: Charles Scribner's Sons.

PARRISH, H., and C. CARR

1967 "Bites by Copperheads *(Ancistrodon contortrix)* in the United States." *American Medical Association Journal*, vol. 201, no. 12, pp. 927-932.

PLATT, D.R.

1973 "Rare, Endangered and Extirpated Species in Kansas, II. Amphibians and Reptiles." *Kansas Academy of Science Transactions,* vol. 76, no. 3, pp. 185-192.

SMITH, H.M.

1956 *Handbook of Amphibians and Reptiles of Kansas.* 2nd ed. University of Kansas, Museum of Natural History miscellaneous publication no. 9.

WEBB, R.G.

1970 *Reptiles of Oklahoma.* Stovall Museum publication no. 2. University of Oklahoma Press.

BIRDS

BETTS, A.J.

1974 "List of Birds seen on the Annual Meeting Field Trip, Kansas Ornithological Society." *Kansas Ornithological Society Newsletter,* vol. 2, no. 3, p. 4.

CLARKE, R., J. BREUKELMAN, and T. ANDREWS

1958 "An Annotated Check List of the Vertebrates of Lyon County, Kansas." *Kansas Academy of Science Transactions,* vol. 81, no. 2, pp. 165-194.

ELY, C.A.

1974 "Midwinter Bird Count for 1974." *Kansas Ornithological Society Bulletin,* vol. 25, no. 1, pp. 1-8.

JOHNSGARD, P.A.

1973 *Grouse and Quails of North America.* Lincoln: University of Nebraska Press.

JOHNSTON, R.F.
1964 *The Breeding Birds of Kansas.* University of Kansas, Museum of Natural History publication, vol. 12.

1965 *A Directory to the Birds of Kansas.* University of Kansas, Museum of Natural History miscellaneous publication no. 41.

KANSAS ACADEMY OF SCIENCE, CONSERVATION COMMITTEE
1974 "Rare, Endangered and Extirpated Species in Kansas, IV. Birds." *Kansas Academy of Science Transactions,* vol. 77, pp. 1-9.

SCHNELL, G.D.
1968 "Differential Habitat Utilization by Wintering Rough-Legged and Red-Tailed Hawks." *Condor,* vol. 70, no. 4, pp. 373-377.

SUTTON, G.M.
1967 *Oklahoma Birds.* Norman: University of Oklahoma Press.

1974 *A Checklist of Oklahoma Birds.* University of Oklahoma, Stovall Museum of Science and History.

THOMPSON, M.C.
1975 "Midwinter Bird Count for 1974." *Kansas Ornithological Society Bulletin,* vol. 26, no. 1, pp. 1-7.

MAMMALS

CARAS, R.A.
1967 *North American Mammals.* New York: Meredith Press.

COCKRUM, E.L.
1952 *Mammals of Kansas.* University of Kansas, Museum of Natural History publication, vol. 7, no. 1.

FRYDENDALL, J.M.
1969 "Rodent Populations on Four Habitats in Central Kansas." *Kansas Academy of Science Transactions,* vol. 72, no. 2, pp. 213-222.

GIER, H.T.
1967 "Vertebrates of the Flint Hills." *Kansas Academy of Science Transactions,* vol. 70, no. 1, pp. 51-59.

HALL, E.R.
1955 *Handbook of Mammals of Kansas.* University of Kansas, Museum of Natural History miscellaneous publication no. 7.

HALL, E.R., and K.R. KELSON
1959 *The Mammals of North America.* New York: Ronald Press.

PLATT, D.R., et al.
1973a "Rare, Endangered, and Extirpated Species in Kansas, I. Fishes." *Kansas Academy of Science Transactions,* vol. 76, no. 2, pp. 97-106.

1973b "Rare, Endangered, and Extirpated Species in Kansas, III. Mammals." *Kansas Academy of Science Transactions,* vol. 76, no. 4, pp. 267-272.

RISSER, P.G., ed.
1974 *Field Guide to Oklahoma.* Norman: Oklahoma Biological Survey.

ARTHROPODS

ANDERSON, N.L.
1961 "Seasonal Losses in Rangeland Vegetation due to Grasshoppers." *Journal of Economic Entomology*, vol. 54, no. 2, pp. 369-378.

BAILEY, S.F.
1948 "Grain and Grass Infesting Thrips." *Journal of Economic Entomology,* vol. 41, pp. 701-706.

BAKER, E.W., et al.
1956 *A Manual of Parasitic Mites of Medical or Economic Importance.* Woodhaven, N.Y.: Henry Tripp.

BLOCKER, H.D.
1969 "The Impact of Insects as Herbivores in Grassland Ecosystems." In *The Grassland Ecosystem: A Preliminary Synthesis.* R.L. Dix and R.G. Beidleman, eds. Colorado State University (Fort Collins), Range Science Department science series no. 2.

BLOCKER, H.D., and R. REED
1971 *1970 Insect Studies at Osage Comprehensive Site.* U.S. IBP technical report no. 93. Colorado State University, Fort Collins, Colorado.

BLOCKER, H.D., T.L. HARVEY, and J.L. LAUNCHBAUGH
1972 "Grassland Leafhoppers, I. Leafhopper Populations of Upland Seeded Pastures at Hays, Kansas." *Entomological Society of America Annals,* vol. 65, pp. 166-172.

BORROR, D.J., and D.M. DELONG
1971 *An Introduction to the Study of Insects.* 3rd ed. New York: Holt, Reinhart and Winston.

BRYANT, H.C.
1912 *Birds in Relation to a Grasshopper Outbreak in California.* University of California zoological publication 11.

BUGBEE, R.E., and A. REIGEL
1945 "The Cactus Moth, *Melitara dentata* (Grote), and its Effect on *Opuntia macrorrhiza* in Western Kansas." *American Midland Naturalist,* vol. 33, pp. 117-127.

BURKE, H.E.
1918 "Notes on some Southwestern Buprestidae." *Journal of Economic Entomology,* vol. 11, no. 2, pp. 209-211.

CHU, H.
1949 *How to Know the Immature Insects.* Dubuque, Iowa: Wm. C. Brown Company.

COLE, A.C., JR.
1968 Pogonomyrmex harvester ants. A study of the genus in North America. Knoxville: University of Tennessee Press.

COMSTOCK, J.H.
1940 *An Introduction to Entomology.* Ithaca, New York: Comstock Publishing Associates.

CRAIGHEAD, F.C.
1920 "Direct Sunlight as a Factor in Forest Insect Control." *Proceedings of the Entomological Society of America,* vol. 22, no. 5, pp. 81-83. Washington, D.C.

1949 *Insect Enemies of Eastern Forests.* United States Department of Agriculture miscellaneous publication no. 657.

DANIEL, N.E.
1966 "The Association of a Rangeland Grub, *Phyllophaga koehleriana* (Coleoptera: Scarabaeidae), with Asilid Larvae and with Mites." *Entomological Society of America Annals,* vol. 59, p. 1021.

DEBACH, P.
1964 *Biological Control of Insect Pests and Weeds.* New York: Reinhold Publishing Corp.

ENGLEMANN, M.D.
1968 "The Role of Soil Arthropods in Community Energetics." *American Zoologist,* vol. 8, pp. 61-69.

ERICKSON, J.M.
1972 "Mark-Recapture Techniques for Population Estimates of Pogonomyrmex Ant Colonies; an Evaluation of the P-32 Techniques." *Entomological Society of America Annals,* vol. 65, no. 1, pp. 57-61.

ESSIG, E.O.
1934 *Insects of Western North America.* New York: The Macmillan Co.

1958 *Insects and Mites of Western North America.* New York: The Macmillan Company.

FELT, E.P.
1940 *Plant Galls and Gall Makers.* Ithaca, New York: Comstock Publishing Associates.

HAMLIN, J.C.
1924 "A review of the Genus Chelinidae (Hemiptera-Heteroptera) with Biological Data." *Entomological Society of America Annals,* vol. 17, pp. 193-208.

HEADLEE, T.J., and G.A. DEAN
1908 *The Moundbuilding Prairie Ant.* Kansas Agricultural Experiment Station bulletin 154.

HEBARD, M.
1938 *An Ecological Survey of the Orthoptera of Oklahoma.* Oklahoma Agricultural Experiment Station technical bulletin 5.

HELFER, J.R.
1953 *How to Know the Grasshoppers, Cockroaches, and their Allies.* Dubuque, Iowa: Wm. C. Brown Company.

HEWITT, G.B., et al.
1974 *Rangeland Ectomology.* Society for Range Management (Denver, Colorado), range science series no. 2. February 1974.

HITCHCOCK, A.S.
1950 *Manual of the Grasses of the United States.* U.S. Department of Agriculture miscellaneous publication no. 200. Washington, D.C.: U.S. Government Printing Office.

HUGGANS, J.L., and C.C. BLICKENSTAFF
1966 *Parasites and Predators of Grasshoppers in Missouri.* University of Missouri Agricultural Experiment Station bulletin 903.

HUNTER, W.D., F.C. PRATT, and J.D. MITCHELL
1912 *The Principal Cactus Insects of the United States.* United States Department of Agriculture, Bureau of Entomology bulletin 113.

JAQUES, H.E.
1951 *How to Know the Beetles.* Dubuque, Iowa: Wm. C. Brown Company.

1947 *How to Know the Insects.* Dubuque, Iowa: Wm. C. Brown Company.

KASTON, B.J.
1952 *How to Know the Spiders.* Dubuque, Iowa: Wm. C. Brown Company.

KNOWLTON, G.F.
1942 "Range Lizards as Insect Predators." *Journal of Economic Entomology,* vol. 35, p. 602.

LAVIGNE, R.J.
1969 "Bionomics and Nest Structure of *Pogonomyrmex occidentalis* (Hymenoptera: Formicidae)." *Entomological Society of America Annals,* vol. 62, no. 5, pp. 1166-1175.

LAVIGNE, R.J., R. KUMAR, J. LEETHAM, and V. KEITH
1972 *Population Densities and Biomass of Above-ground Arthropods under Various Grazing and Environmental Stress Treatments on the Pawnee Site, 1971.* U.S. IBP Grassland Biome technical report 204.

LAVIGNE, R.J., L.E. ROGERS, and J. CHU

1971 *Data Collected on the Pawnee Site Relating to Western Harvester Ant and Insect Predators and Parasites, 1970.* U.S. IBP Grassland Biome technical report 107.

LITTLE, V.A.

1957 *General and Applied Entomology.* New York: Harper and Row, Publishers.

MALCOLM, D.R.

1955 *Biology and Control of the Timothy Mite* (Paratetranychus pratensis Banks). Washington Agricultural Experiment Station technical bulletin 17.

MCDANIEL, B.

1971 "The Role of Invertebrates in the Grassland Biome." In *Preliminary Analysis of Structure and Function in Grasslands.* N.R. French, ed. Colorado State University (Fort Collins), Range Science Department science series no. 10. 387 pp.

METCALF, C.L., W.P. FLINT, and R.L. METCALF

1962 *Destructive and Useful Insects.* 4th ed. New York: McGraw-Hill Book Company, Inc.

MORRIS, M.G.

1971 "Differences between the Invertebrate Faunas of Grazed and Ungrazed Chalk Grassland, IV. Abundance and Diversity of Homoptera-Auchenorhyncha." *Journal of Applied Ecology,* vol. 8, pp. 37-52.

MUENSCHER, W.C.

1947 *Poisonous Plants of the United States.* New York: The Macmillan Company.

PHILLIPS, W.J.

1920 *Studies on the Life History and Habits of the Jointworm Flies of the Genus* Harmolita *(Isosoma) with Recommendations for Control.* United States Department of Agriculture bulletin 808.

POHL, R.E.

1953 *How to Know the Grasses.* Dubuque, Iowa: Wm. C. Brown Company.

PRESCOTT, H.W.

1960 "Suppression of Grasshoppers by Numestrinid Parasites (Diptera)." *Entomological Society of America Annals,* vol. 53, pp. 513-521.

PUTNAM, L.G.

1962 "The Damage Potential of some Grasshoppers (Orthoptera:Acrididae) of the Native Grasslands of British Columbia." *Canadian Journal of Plant Science,* vol. 42, pp. 596-601.

REES, N.E.

1972 *Arthropod and Nematode Parasites, Parasitoids, and Predators or Acrididae in America North of Mexico.* United States Department of Agriculture technical bulletin 1460.

RIHERD, P.T.

1954 "Thrips, a Limiting Factor in Seed Production." *Journal of Economic Entomology,* vol. 47, pp. 709-710.

ROGERS, L.E., and R.J. LAVIGNE

1972 *Asilidae of the Pawnee National Grasslands in Northeastern Colorado.* University of Wyoming, Agricultural Experiment Station scientific monograph 25.

ROSS, H.H.

1948 *A Textbook of Entomology.* New York: John Wiley & Sons, Inc.

SABROSKY, C.W.

1967 "Two New Chloropidae, One of which Seriously Affects Seed Production in Range Grasses, Notably Alkali Sacaton." *Kansas Entomological Society Journal,* vol. 40, pp. 151-156.

SMITH, C.C.

1940 "The Effect of Overgrazing and Erosion upon the Biota of the Mixed Grass Prairie of Oklahoma." *Ecology,* vol. 21, pp. 381-397.

SMITH, R.C.

1954 "An Analysis of 100 Years of Grasshopper Populations in Kansas (1854-1954)." *Kansas Academy of Science Transactions,* vol. 57, pp. 397-433.

SMITH, R.C., et al.

1943 *Common Insects of Kansas.* Report of the Kansas State Board of Agriculture. Topeka, Kansas: Kansas State Printing Plant, W.C. Austin, State Printer.

UECKERT, D.N., and M.C. BODINE
1971 "Rangeland Termites." In *Noxious Brush and Weed Control Research Highlights.* Texas Technical University.

WALKDEN, H.H.
1943 "Cutworm and Armyworm Populations in Pasture Grasses, Wastelands and Forage Crops." *Journal of Economic Entomology,* vol. 36, pp. 376-381.

WATTS, J.G., and A.C. BELLOTTI
1967 "Some New and Little-Known Insects of Economic Importance on Range Grasses." *Journal of Economic Entomology,* vol. 60, pp. 961-963.

WEBER, N.A.
1959 "The Stings of the Harvestering Ant, *Pogonomyrmex occidentalis* (Cresson) with a Note on Populations (Hymenoptera)." *Entomological News,* vol. 70, pp. 85-90.

WILBUR, D.A., and R.F. FRITZ
1940 "Grasshopper Populations (Orthoptera:Acrididae) of Typical Pastures in the Bluestem Region of Kansas." *Kansas Entomological Society Journal,* vol. 13, pp. 86-100.

WILBUR, D.A., and C.W. SABROSKY
1936 "Chloropid Populations on Grasses in Kansas." *Journal of Economic Entomology,* vol. 29, pp. 384-389.

WINSLOW, R.B.
1960 "The Acridiophagous Sarcophaga (Diptera: Sarcaphagidae) of Colorado." Unpublished master of science thesis. Colorado State University, Fort Collins, Colorado.

WYMORE, F.H.
1934 "Cicadas in Relation to Agriculture." *Journal of Economic Entomology,* vol. 24, no. 5, pp. 884-891.

G: LAND USE AND DEMOGRAPHIC CHARACTERISTICS

LAND USE AND
DEMOGRAPHIC CHARACTERISTICS
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
Department of Landscape Architecture
Kansas State University

CONTENTS

MAPS

---

*These maps, prepared at 1:24,000 scale, are not reproducible without unacceptable loss of information. All these maps can be reviewed at the National Park Service's Denver Service Center. Some can be reproduced full scale on request and at the expense of the requestor.

INTRODUCTION

This land-use study consists of an inventory of existing and planned land uses as they relate to the Wabaunsee, Chase, and Osage study areas. The inventory was prepared by five 5th-year landscape architecture undergraduates from Kansas State University.* The land-use information was mapped at three scales. Study area maps were prepared at a scale of 1:24,000 on 7½ minute USGS base maps. Maps illustrating uses on lands extending from study-area boundaries out to 6 miles from the boundaries were prepared at a scale of ½ inch = 1 mile. Regional land uses were mapped on USGS base maps at a scale of 1:250,000.

Important aspects of human activity and patterns of land use considered in this study include population characteristics, adaptability of land uses for park use, and visual compatibility of land uses with a Prairie National Park.

Aerial stereo photographs (at scales of 1:20,000 for Wabaunsee and Chase and 1:40,000 for Osage) were interpreted, and the information was mapped on the study-area base maps. All mapped information was field-checked. Information about planned land use was gained mainly from state and federal agencies in Kansas and Oklahoma. Care was taken to contact the same or comparable agencies in each state. A listing of agency contacts is found at the end of this section.

*Larry Walling, Roger Denton, Larry Monahan, Terry Smythe, and Dan McClelland.

DEMOGRAPHIC CHARACTERISTICS

The historical use of the prairie in the Flint Hills has been primarily cattle production (see Cultural Resources, appendix H). Although historically the economy of the counties within and adjacent to the three study areas has been based for the most part on the grazing and breeding of migrant and local cattle, today the majority of the population in these counties is classified as rural non-farm (1970 U.S. Census) – people who reside in rural areas but do not receive an income from agriculture.

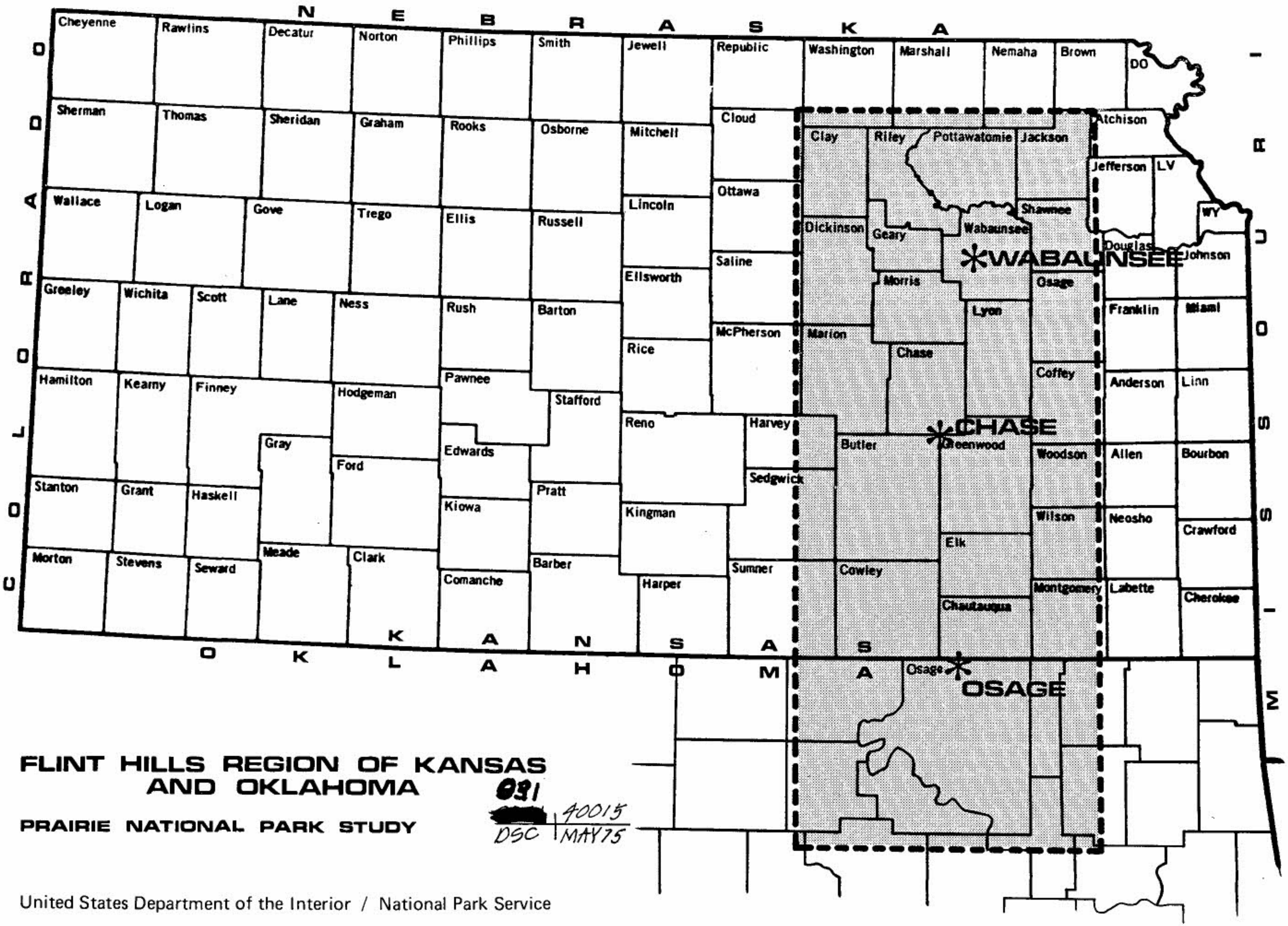
There are several trends common to most of the counties associated with the three study areas. With a few exceptions, the counties are experiencing an out-migration of people, list a high median age, and show the greatest percentage of the people classified as urban or rural non-farm.

The following list shows the counties in Kansas and Oklahoma associated with each study area. (See Flint Hills Region map, PRAI 40,015.)

Study Area	Counties Directly Affected	Counties Immediately Adjacent
Wabaunsee	Wabaunsee	Pottawatomie Riley Geary Morris Lyon
Chase	Chase Butler Greenwood	Lyon Morris
Osage	Osage (Oklahoma) Cowley Chautauqua	

WABAUNSEE STUDY AREA

The six counties surrounding or encompassing the Wabaunsee study area are classified as urban or rural non-farm. Riley and Geary Counties are classified urban, with 74.5 percent of the population residing in Manhattan, Junction City, Topeka, and smaller towns. Lyon County is also classified as urban, with 72.7 percent residing in Emporia and other urbanized areas.



FLINT HILLS REGION OF KANSAS AND OKLAHOMA

031

[redacted] 40015
DSC MAY75

PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

Riley and Lyon Counties are experiencing an influx of people (Riley — 20 percent; Lyon — 11 percent), while the other counties are losing population (see table 1). Although there is a very high percentage of land in agriculture within these counties, all are experiencing a slight shift from rural to more urban uses (see table 1); between 1960 and 1970 Wabaunsee County witnessed a 9.6-percent shift from rural to urban land use. Riley, Geary, and Lyon Counties have a lower than average median age, while the other counties' median ages are higher than average (see table 1); the median age for Wabaunsee County was 36.7 in 1970.

Wabaunsee County exhibits the typical characteristics of a rural area in the Flint Hills: extensive rangeland, with many large landholdings; a gradual out-migration of people; and rural residents generally above the median age and frequently employed in surrounding urban areas. Because the surrounding counties all have urban employment centers, Wabaunsee County, and particularly the Wabaunsee study area, in a sense represents an "island" of rural rangeland surrounded by urbanized areas.

CHASE STUDY AREA

The five counties associated with the Chase study area are classified as rural non-farm or urban. These counties are experiencing an out-migration of the younger population, reflected by an above-average median age in Morris, Chase, Greenwood, and Butler Counties. The majority of the land is classified as agricultural (see table 1). The counties within the Chase study area are similar in demographic characteristics internally.

While nearby Wichita, Emporia, Topeka, and Junction City exert strong regional urban influences, these rapidly developing urban areas are not as geographically immediate to the Chase study area as they are to the Wabaunsee study area.

OSAGE STUDY AREA

Chautauqua County, Kansas, and Osage County, Oklahoma, are classified rural non-farm, while Cowley County, Kansas, is classified urban because of the influence of Wichita, Arkansas City, and Winfield.

The Osage Indian Reservation is in Osage County, Oklahoma, with the tribal council at Pawhuska. The Osage Reservation, authorized in 1872, was incorporated as the state's largest county when Oklahoma was admitted to the Union in 1907. Originally, the lands of the Osage extended over much of Missouri and also included large segments of Arkansas, Kansas, and Oklahoma. By treaties concluded in 1808, 1818, 1829, 1865, and 1871, these lands were ceded to the United States. In 1871-1872 the Osage were

TABLE 1.

	Population Characteristics						Land Charac.		Age & Education		
	Urban	Rural Non-Farm	Rural	Migration	Rural Ch 1960-70	Pop. per Sq. Mile	% in Agric.	Change	Median Age	Median Educ.	Unemployment
Kansas	66.1	23.3	10.6	- 6.1	-25.8	28	94.4	- 1.8	29.0	12.3	3.9
Counties											
Wabaunsee	0	62.2	37.7	- 4.2	- 4.2	8	90.6	- 9.6	36.7	12.1	.8
Pottawatomie	27.3	48.4	24.3	- 4.7	-31.9	14	88.2	- 3.5	33.8	12.2	2.1
Riley	74.5	22.4	2.9	20.2	-46.2	95	67.8	-21.8	21.2	12.7	4.1
Geary	83.9	14.2	1.8	-29.6	-29.0	75	-13.0	-11.3	22.9	12.4	6.0
Morris	0	66.7	33.2	-13.5	-24.8	9	83.7	-13.2	41.0	12.1	1.3
Lyon	72.7	16.2	11.1	11.2	-20.6	38	82.6	- 7.2	24.0	12.5	5.4
Chase	0	69.5	30.4	-13.3	-40.7	4	87.0	- 4.1	41.7	12.2	2.1
Butler	47.1	41.5	11.4	- 6.6	-19.2	27	87.3	- 1.9	30.1	12.3	6.3
Greenwood	40.7	38.7	20.4	-18.3	-32.3	8	93.2	- 6.7	42.3	12.0	2.9
Chautauqua	0	78.3	21.7	-17.6	-42.4	7	90.9	- 5.3	46.9	11.2	3.0
Cowley	70.8	18.2	10.9	-10.3	-27.2	31	85.0	-12.8	34.3	12.2	4.7
Oklahoma	68.0	25.1	6.8	.6	-32.3	37	81.8	- .2	29.7	12.1	4.2
County											
Osage	30.0	59.6	10.4	-12.1	-24.2	13	84.3	- 4.4	34.7	11.5	4.9

Source: 1970 Census, *County and City Data Book, 1972.* Bureau of Census, U.S. Department of Commerce, Washington, D.C., 1973.

removed to a reservation in Indian Territory authorized by an act of June 5, 1872. The Indians have since sold much of their surface rights in what was their reservation, but they still retain the mineral rights. Today only 8.6 percent of the population of Osage County is Indian. Less than 1 percent of the population of all other counties is Indian.

Compared to the other counties in this study, Chautauqua and Osage Counties have a relatively low median education level – approximately 11.3 years of completed schooling. In the overall state of Oklahoma statistics, Osage County has a relatively high unemployment rate compared to the state as a whole. Osage, Chautauqua, and Cowley Counties have a high percentage of land in agriculture, and the trend is to remain agricultural rather than to convert to other uses (such as urban). The three counties encompassing the Osage study area are experiencing a migration of young people to urban areas. A characteristic unique to this three-county area is the relatively high percentage of American Indians in the total population.

SUMMARY

The counties associated with the Wabaunsee and Chase study areas are classified as urban or rural non-farm, while the Osage study area is classified as rural non-farm. In general, there is a high rate of out-migration from rural areas to more urbanized areas within the region. It is primarily the younger population who are moving from the rural areas, leaving the counties with high median age groups. (The median age of Chautauqua County is 46.9.) The Wabaunsee study area is in more immediate proximity to urbanized counties than the Chase study area, and, because of difficulty of access, the Osage area is even more remote than Chase.

The counties encompassing the Osage study area generally follow the trends of the other counties with two important exceptions: These counties are remaining agricultural rather than becoming urbanized, and Osage County is the boundary for the Osage Indian Reservation. The Osage Indians have maintained their mineral rights as well as the right to reclaim their surface land rights.

LAND USES: WABAUNSEE STUDY AREA

USES WITHIN THE STUDY AREA

The northern fringe of this 80,000-acre study area is 1½ miles south of the Wabaunsee County Seat of Alma, Kansas. Land-use patterns evident from the inventory are:

Woodlands – Tree cover follows creek valleys and major drainages, occupying 9,213 acres or 11 percent of the area. Woody vegetation occurs in these areas primarily due to availability of moisture and the presence of a favorable soil profile.

Croplands – Because of the extensive alluvial soils, the valleys are extensively cropped. Other extensive croplands occur on glacial drift in the southwest portion of the study area. This is an upland cropping situation. Some 7,723 acres or 11 percent of the study area is in cropland.

Rangelands – Grassland that is currently used for grazing purposes comprises 63,405 acres or 79 percent of the study area.

Residential – The overriding factor in establishing a homestead in this region was the availability of water. As a result, early homesteading and modern residential uses have developed in protected, moist valleys along the transportation network.

Industrial-Extractive – One oil field and several isolated oil wells are found within the Wabaunsee area.

Utilities – No high-voltage transmission lines or pipelines are situated within the study area, but one transmission line abuts its northern tip.

Communication Towers – There are no communication towers within the study area.

Water – Within the study area, numerous stock ponds are found, but these seem surprisingly few compared to the regional scene. Large reservoirs do not exist.

(See enclosure 1 and Wabaunsee Land Use map, PRAI 40,046, for detailed information.)

LAND USE, WABAUNSEE *

USES WITHIN SIX MILES OF THE STUDY AREA

Urbanization – Five communities exist within the 6-mile area. Alma, north of the study area, has a population of 905 and is the county seat of Wabaunsee County. McFarland, northeast of the area, has a population of 589. On the western fringe of the study area is Alta Vista, with a population of 402. Dwight, 4 miles west and south of the area, has a population of 322. Lake Wabaunsee has 239 dwelling units. Because it is primarily a recreational community, Lake Wabaunsee's population fluctuates seasonally and population figures are not obtainable.

Railroads – The Chicago, Rock Island, and Pacific Railroad line borders the 6-mile northwest edge of the study area between Alta Vista and Alma. A dismantled line connects Alma to Eskridge.

Communication Towers – There is a microwave tower 2¼ miles south of the southeast corner of the study area.

Oil Wells – South of the study area there are three small oil fields, one within ½ mile. All have fewer than six oil wells.

Highways – Interstate 70 runs east and west through the north portion of the 6-mile area about 5 miles north of the study area. Kansas 177, the "Prairie Parkway," is found about 1 mile west running north to south. Kansas 4 enters the 6-mile area on the west at Dwight and exits at Eskridge on the east, traversing the southern portion of the study area. Kansas 99 connects I-35 (the Kansas Turnpike) with I-70, running through Alma and the study area; K-99 is coincident with K-4 for a portion of its distance.

Development Patterns – Numerous cemeteries, churches, schoolhouses, and farm dwellings exist within the 6-mile area. The heaviest concentration of such development is in the Alma area and south and west of the study area.

(See Existing Land Use, Wabaunsee, PRAI 40,051.)

THIRTY-MILE ZONE OF INFLUENCE

Within a 30-mile radius of the Wabaunsee area, numerous recreation opportunities are available. Federal recreation lands are located at Tuttle Creek and Council Grove Reservoirs. The proposed Onaga Reservoir will also provide recreation opportunities.

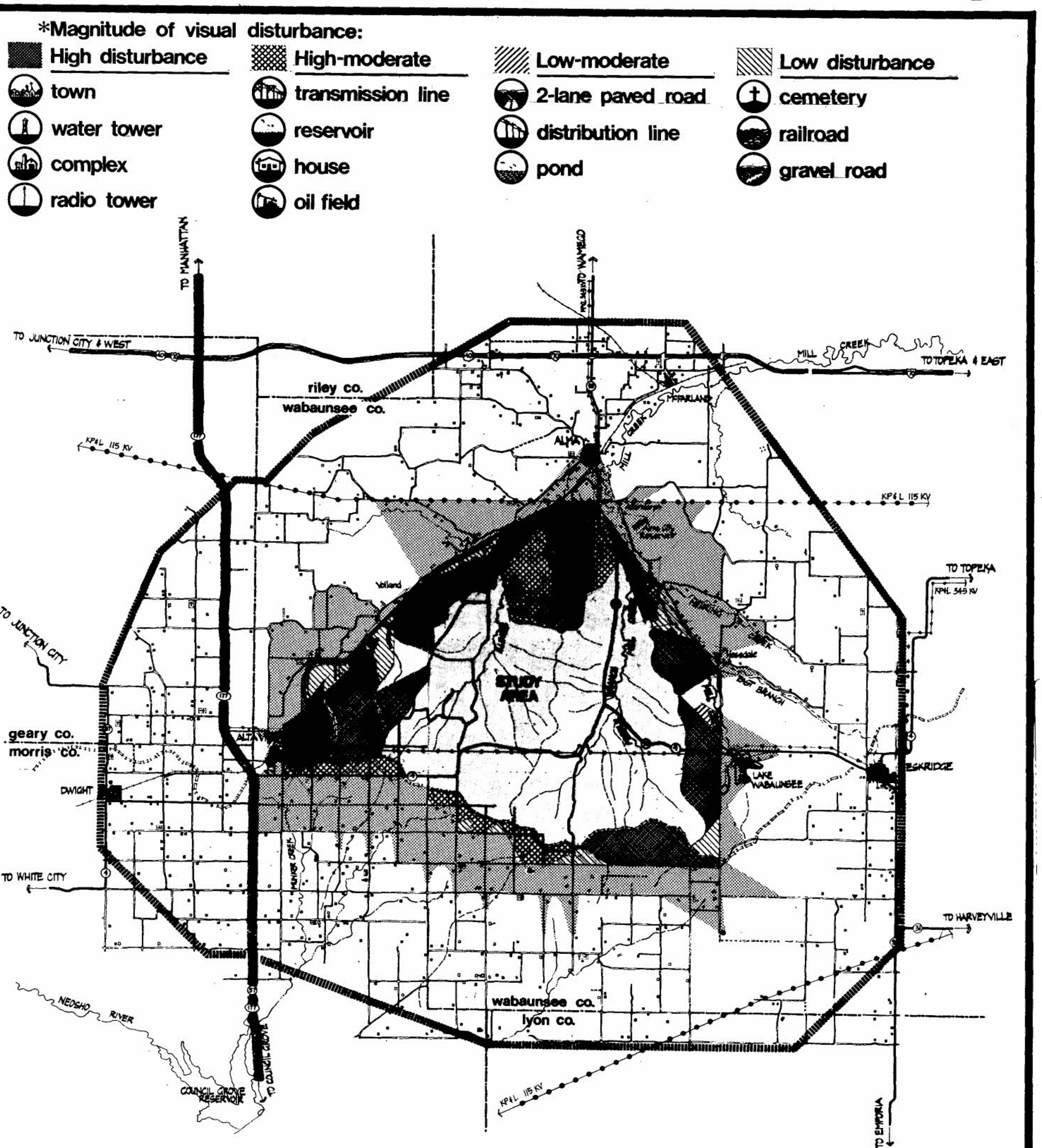
State-designated scenic rivers within the 30-mile zone include Smoky Hill River, Rock Creek, Vermillion Creek, and Hill Creek to the north and the Wakarusa River east of the area. (See Flint Hills Region, Land Use, PRAI 40,049.)

Four air routes traverse the 30-mile zone: one from Wichita to Topeka, another from Emporia to Topeka, a third from Dodge City to Kansas City, and one from Emporia to Manhattan.

The Wabaunsee study area has direct access to Interstate 70 via K-99. Kansas 177, the Prairie Parkway, borders the western edge of the study area. U.S. 56 lies approximately 15 miles south of the area on an east-west line. (See PRAI 40,049.)

Urban centers within 30 miles of the study area are Manhattan, Junction City, Council Grove, Wamego, Paxico, and Eskridge. The towns of Alma and Alta Vista are located on the study area fringes. (See PRAI 40,049.)

The Jeffrey Energy Center is now under construction north of the Kansas River within the Wabaunsee study area's 30-mile zone. Planned transmission lines from this plant will generally be routed in northwest, northeast, southeast, and west directions. They will be 230-kilovolt, single-phase, H-frame wood pole lines and should not directly affect the study area. Should future lines be routed to Wichita, the western portion of the study area could be affected. (See PRAI 40,050 and enclosure 1 for detailed information.)



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA (within 6 miles)

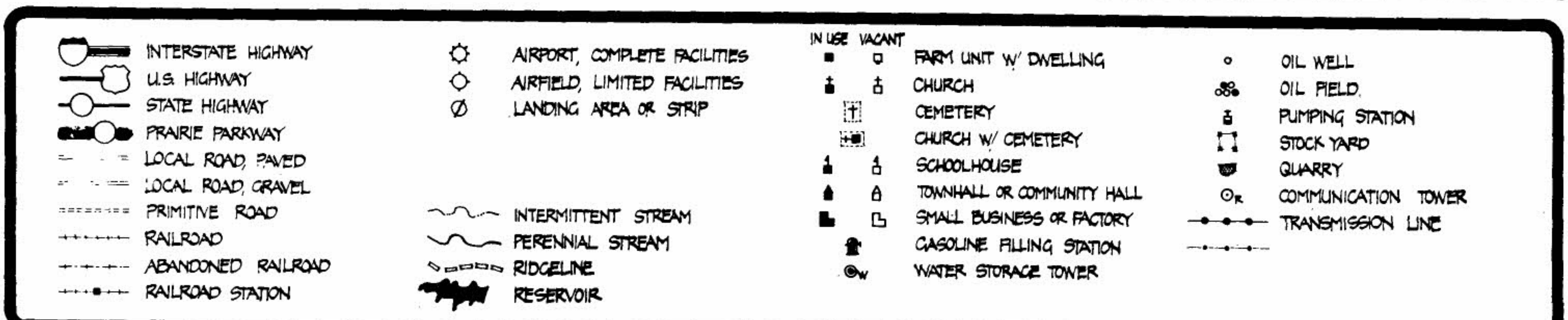
WABAUNSEE

PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

831 / 40051
DSC / MAY 75

0 1 2 4 6 miles



ON MICROFILM

FLINT HILLS REGION, LAND USE
TRANSPORTATION, RECREATION, URBANIZATION *

FLINT HILLS REGION, LAND USE
TRANSPORTATION, UTILITIES *

LAND USES: CHASE STUDY AREA

USES WITHIN THE STUDY AREA

Located in Chase, Greenwood, and Butler Counties, Kansas, the Chase study area encompasses about 102,000 acres. A number of land-use patterns exist within or adjacent to the area.

Woodlands – Tree cover is found in the major valleys and occupies 2,297 acres or 2 percent of the area.

Croplands – Valleys provide the prime setting for this agricultural activity. Only one occurrence of upland cropping exists within the study area. Croplands occupy 1,316 acres or 1 percent of the area.

Rangelands – 96,387 acres or 97 percent of the area is currently used for grazing purposes.

Residential – Homes are generally located along transportation routes and wooded valleys.

Industrial-Extractive – Two oil fields are located within the area. Four oil fields are located directly outside of the area to the east.

Utilities – Eight major and service pipelines traverse the area.

Communication Towers – Three communication towers are located within the area, including a massive microwave facility in the north-central portion of the area.

Water – Stock ponds are found throughout the area. Otis Creek Reservoir is outside the study area to the south. Large water impoundments are found in the area – one in its northeast corner on the Verdigris River and three on the headwaters of the west branch of Fall River.

(See enclosure 2 for detailed information and Chase Land Use map, PRAI 40,047.)

USES WITHIN SIX MILES OF THE STUDY AREA

Urbanization – Matfield Green, population 77, and Cassoday, population 123, are the only communities within the 6-mile area.

LAND USE, CHASE *

Railroads — One railroad can be found, located parallel to K-177 west of the study area.

Utilities — A 345-kilovolt, H-frame wood pole line cuts diagonally across the 6-mile area and the north end of the study area from southwest to northeast.

Communication Towers — Two radio towers exist within the 6-mile area — one is 3 miles north of Cassoday along K-177 on the Chase County/Butler County line and the other 3 miles north of the area adjacent to I-35, 1 mile inside Chase County.

Oil Fields — An extensive oil field blankets the south and east portion of the 6-mile zone.

Highways — Interstate 35 enters the 6-mile area southwest of Cassoday and forms the diagonal north boundary of the study area. An interchange is located at Cassoday and a service plaza has been built near Matfield Green. Kansas 177 traverses the west portion of the 6-mile area. Grid-pattern county roads in the 6-mile area are more abundant to the east and west of the study area.

(See Existing Land Use, Chase, PRAI 40,052.)

THIRTY-MILE INFLUENCE ZONE

Recreation opportunities within the 30-mile zone lie mainly to the north in the Cottonwood Falls area. The only federal lands will be those located at the El Dorado Reservoir (under construction) and the proposed Cedar Point Reservoir.

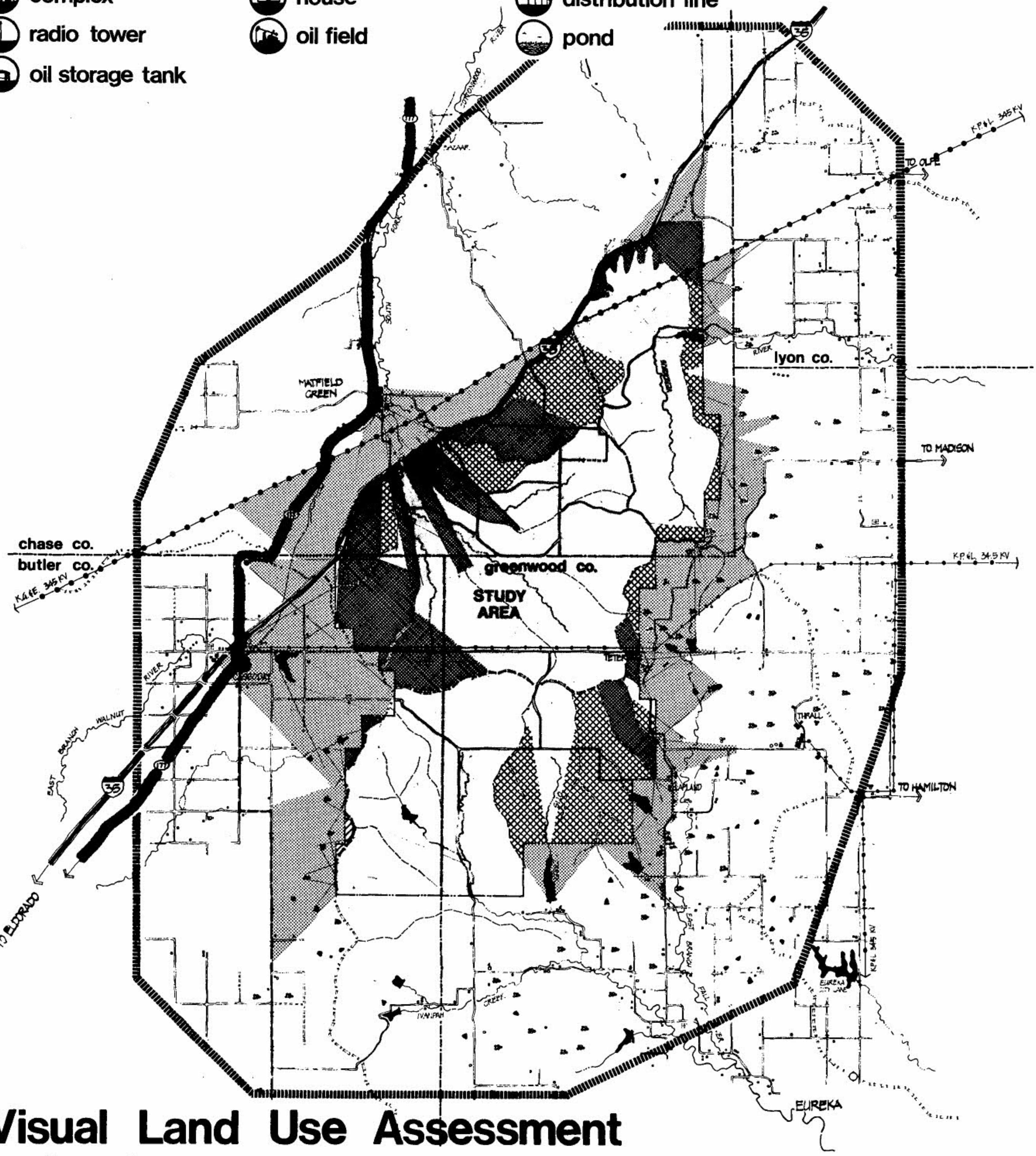
Matfield Green Grassland, a reported 5,000-acre preserve, is close to the study area on the north. State-designated scenic rivers partially within the 30-mile zone include Diamond Creek; Fall River, which has its beginnings within the study area itself; and the Walnut River. (See PRAI 40,049.)

Three air routes from Wichita to Kansas City cross the extreme north portion of the study area. Another route follows a line from Marion directly through the center of the area to Joplin, Missouri. The remaining air routes within the 30-mile zone are between Wichita and Topeka, Manhattan and Emporia, and Emporia and Joplin. Airports are located at Cottonwood Falls, Emporia, Eureka, and El Dorado.

Northeast of the area is Emporia, largest city within the 30-mile zone. Eureka and El Dorado are approximately 20 miles south. Twenty miles north are Cottonwood Falls, Strong City, and Elmdale. One mile northwest is the community of Matfield Green. (See PRAI 40,049 and enclosure 2 for detailed information.)

*Magnitude of visual disturbance:

High disturbance	High-moderate	Low-moderate	Low disturbance
town	transmission line	4-lane paved road	gravel road
water tower	reservoir	2-lane paved road	
complex	house	distribution line	
radio tower	oil field	pond	
oil storage tank			



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA (within 6 miles)

CHASE
PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

031 / 40052
DSC / MAY 75

0 1 2 4 6 miles

INTERSTATE HIGHWAY	AIRPORT, COMPLETE FACILITIES	(IN USE / VACANT) FARM UNIT W/ DWELLING	OIL WELL	
U.S. HIGHWAY	AIRFIELD, LIMITED FACILITIES	CHURCH	OIL FIELD	
STATE HIGHWAY	LANDING AREA OR STRIP	CEMETERY	PUMPING STATION	
PRAIRIE PARKWAY		CHURCH W/ CEMETERY	STOCK YARD	
LOCAL ROAD, PAVED		SCHOOLHOUSE	QUARRY	
LOCAL ROAD, GRAVEL		TOWNHALL OR COMMUNITY HALL	COMMUNICATION TOWER	
PRIMITIVE ROAD	INTERMITTENT STREAM	SMALL BUSINESS OR FACTORY	TRANSMISSION LINE	
RAILROAD	PERENNIAL STREAM	GASOLINE FILLING STATION		
ABANDONED RAILROAD	RIDGELINE	WATER STORAGE TOWER		
RAILROAD STATION	RESERVOIR			

ON MICROFILM

LAND USES: OSAGE STUDY AREA

USES WITHIN THE STUDY AREA

One-fifth of the approximately 98,000-acre Osage study area is situated in the Kansas counties of Cowley and Chautauqua. The remainder of the area is in Osage County, Oklahoma. The existing land uses are:

Woodlands – The Caney River Valley in Kansas and other major drainages in Oklahoma are all tree covered. Cross-timbers vegetation occupies some uplands on the east side, and extensive upland forests occupy steep slopes in the northwest portion of the area. Collectively, woodlands make up 6,673 acres or 7 percent of the area.

Croplands – Cropping dominates the Caney River Valley. Only two other small, isolated cropped areas exist, for a total of 2,483 acres or 3 percent of the area.

Rangelands – 88,746 acres or 90 percent of the area is currently used for grazing purposes.

Residential – The heaviest concentration of housing occurs in the Caney River Valley. Sixteen other homes are widely scattered over the study area.

Industrial-Extractive – Four small oil fields are located in the area.

Utilities – Two pipelines traverse the study area in an east-west direction – one through the north portion and one through the south.

Communication Towers – None exist within the study area.

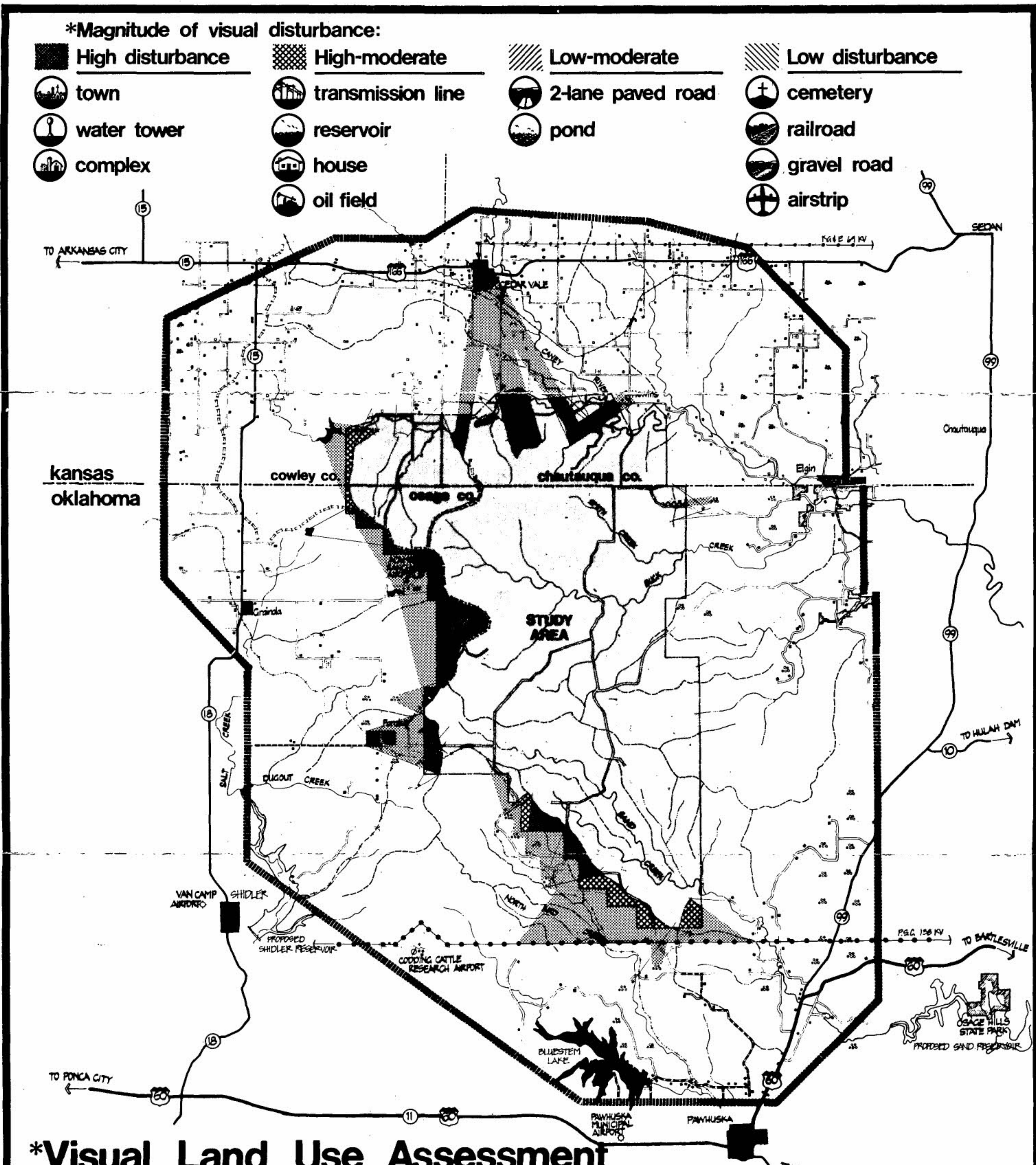
Water – Small stock ponds are found throughout the study area. Within the study area one reservoir is located just inside the Oklahoma state line north of Foraker on Acker Creek. Just outside the study area, also north of Foraker but in a different watershed, are two reservoirs associated with the Adams Ranch complex.

(See Osage Land Use map, PRAI 40,048, and enclosure 3 for detailed information.)

USES WITHIN SIX MILES OF THE STUDY AREA

Urbanization – In Kansas, Cedar Vale (population 665), Hewins (population unknown), and Elgin (population 115), are found within the 6-mile area. In

LAND USE, OSAGE *



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA

(within 6 miles)

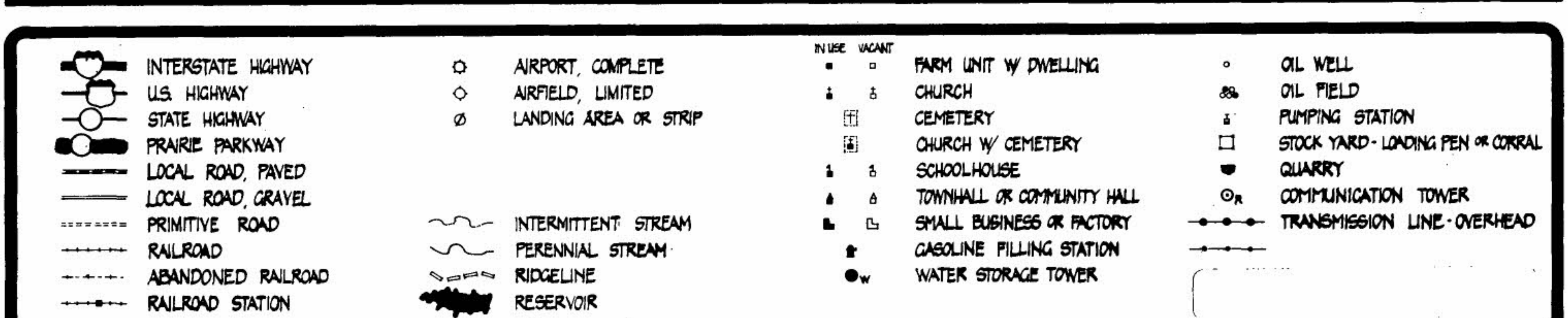
031
40053
D6C MAY 75

OSAGE

PRAIRIE NATIONAL PARK STUDY

0 1 2 4 6
miles

United States Department of the Interior / National Park Service



ON MICROFILM

Oklahoma, Grainola (population 66) and Foraker (population 52) are located within the surrounding 6-mile area.

Railroads – A dismantled railroad from Pawhuska, south of the area, meanders northwest through Foraker and Grainola. Another railroad enters Vale from the west.

Utilities – A 138-kilovolt line runs east and west just south of the study area.

Communication Towers – None exist within the 6-mile area.

Oil Fields – Oil fields surround the study area on all sides but the north and northwest.

Highways – U.S. 166 runs east and west about 5 miles north of the area. Kansas 15 and Oklahoma 18, running north and south, are about equidistant from the west side of the study area. U.S. 60 and Oklahoma 99 serve Pawhuska and the south end of the 6-mile zone. The absence of gridded county roads is evident southwest and east of the study area.

Residential – The majority of farm dwellings occurs north of the study area in Kansas.

Reservoirs – The upper reaches of Hulah and planned Shidler Reservoirs are within the 6-mile area.

(See Existing Land Use, Osage, PRAI 40,053.)

THIRTY-MILE INFLUENCE ZONE

Recreation facilities are scattered throughout the 30-mile zone. Federal recreation lands exist at Hulah Reservoir. Federal areas will also be located at the Kaw, Birch, and Copan Reservoirs, which are presently under construction. The planned reservoirs of Shidler and Sand will also have recreation areas.

State-designated scenic rivers within the 30-mile zone are Caney River, bordering the northern portion of the study area, and Grouse Creek, approximately 25 miles northwest. Rivers in Oklahoma have not been given such designation. (See PRAI 40,049.)

An air route from Tulsa to Wichita comes within 2 miles of the area. Another air route between Ponca City and Dewey crosses the southern portion. In Oklahoma, airports

are located near Ponca City, Fairfax, Pawhuska, Bartlesville, and Dewey. One airfield is located on the western fringe of the study area.

Three proposed four-lane, divided highways are planned within 30 miles of the area. The Southeast Kansas Toll Road begins near Winfield and will travel east to Galena, coming within 15 miles of the north edge of the area. The second highway, located in Oklahoma, begins west of Ponca City and follows U.S. 60 east to Pawhuska, then swings southeast toward Tulsa. This highway will come within 5 miles of the area. The third highway will be located between Pawhuska and Bartlesville, passing south of the proposed Sand Reservoir. (See PRAI 40,049.)

Urban centers within the 30-mile zone are Pawhuska, Bartlesville, Dewey, and Fairfax in Oklahoma and Caney, Sedan, Chautauqua, and Cedar Vale in Kansas. Three smaller communities are located closer to the area: Hewins to the north, Elgin to the east, and Foraker to the west. (See PRAI 40,049 and enclosure 3 for detailed information.)

REGIONAL LAND-USE PLANNING

Within the Flint Hills, the main industry is agriculture, especially agriculture closely related to or dependent upon the cattle industry. Because of this economic base, planning conducted within the region concentrates mainly on diversifying that base and enabling local and county governments to procure federal funds for capital improvements. These planning efforts take place within established Kansas planning regions and regional planning commissions. Their respective districts do not correspond. In Oklahoma, the Indian Nations Council of Governments coordinates regional planning efforts for northeastern Oklahoma. The Soil Conservation Service, state highway departments, and Corps of Engineers are also engaged in regional planning efforts.

KANSAS PLANNING REGIONS

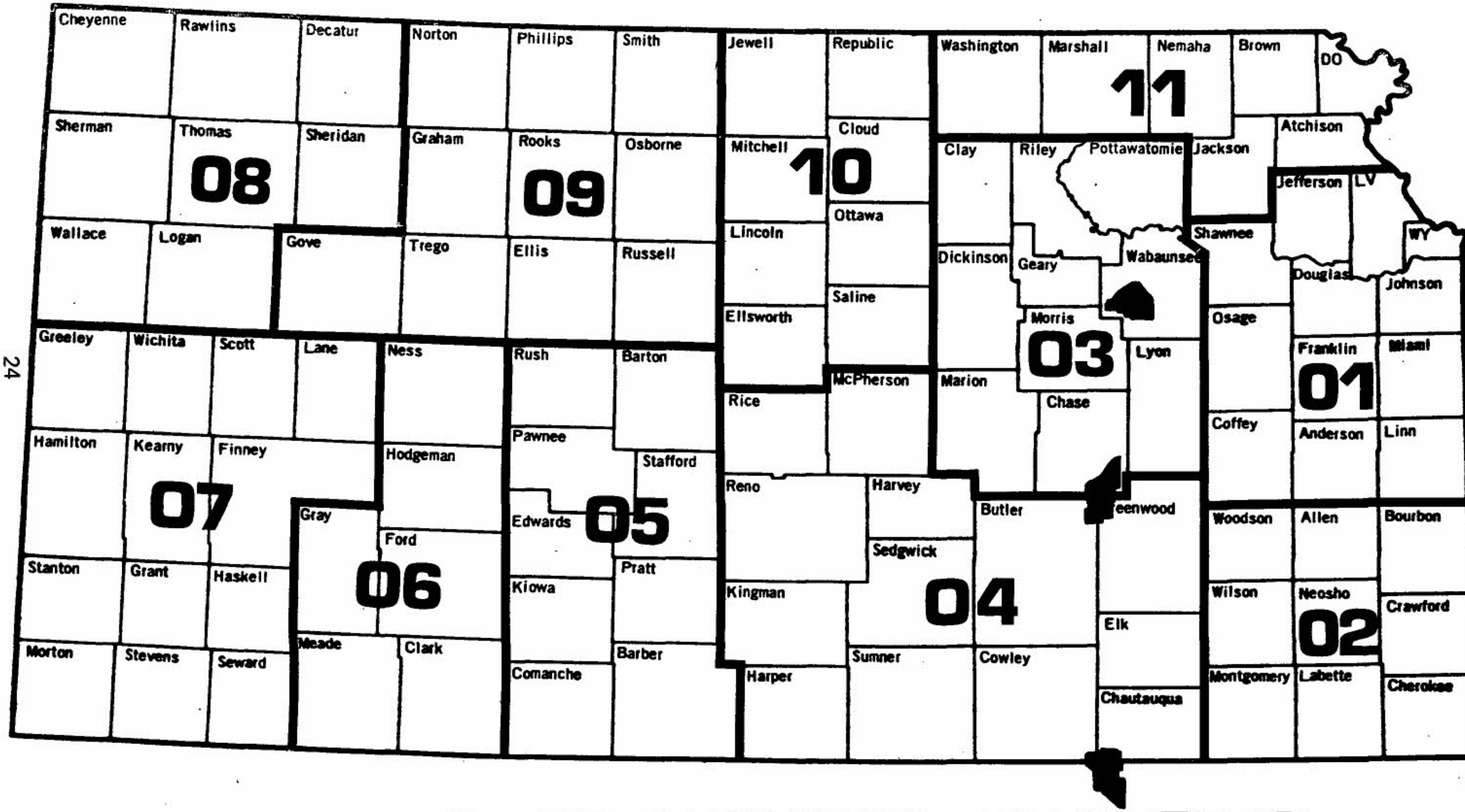
These planning regions were designated in 1971 as substate regions for purposes of coordination between federal, state, and local plans and projects. The designated regions are still not legally binding but are strongly recommended for use by each agency that has regional programs. Currently several agencies do not use these regions or have not realigned their programs to follow them. The Flint Hills Region of Kansas lies within Region-03 and the eastern half of Region-04. (See PRAI 40,081.)

Independent of these state-designated regions, multi-county regional planning commissions have been organized to achieve governmental coordination, but they are not intended to create another level of government. They meet to discuss related problems and implement plans to solve these problems. Funding is handled through local contributions by member counties and cities, federal grants and funds, some state funds, and some private donations.

Regional planning commissions within the Flint Hills Region of Kansas include:

Big Lakes Regional Planning Commission – Planning has been accomplished by using consultants and other agencies. The major resource facility has been Kansas State University, which houses representatives of many federal and state programs as well as the Department of Regional and Community Planning and the Cooperative Extension Service. Member counties are Clay, Geary, Pottawatomie, and Riley.

Flint Hills Regional Planning Commission – This commission, resulting from *efforts by the Flint Hills Resource Conservation and Development Project*, directs planning in the area and helps secure federal funds. This working relationship

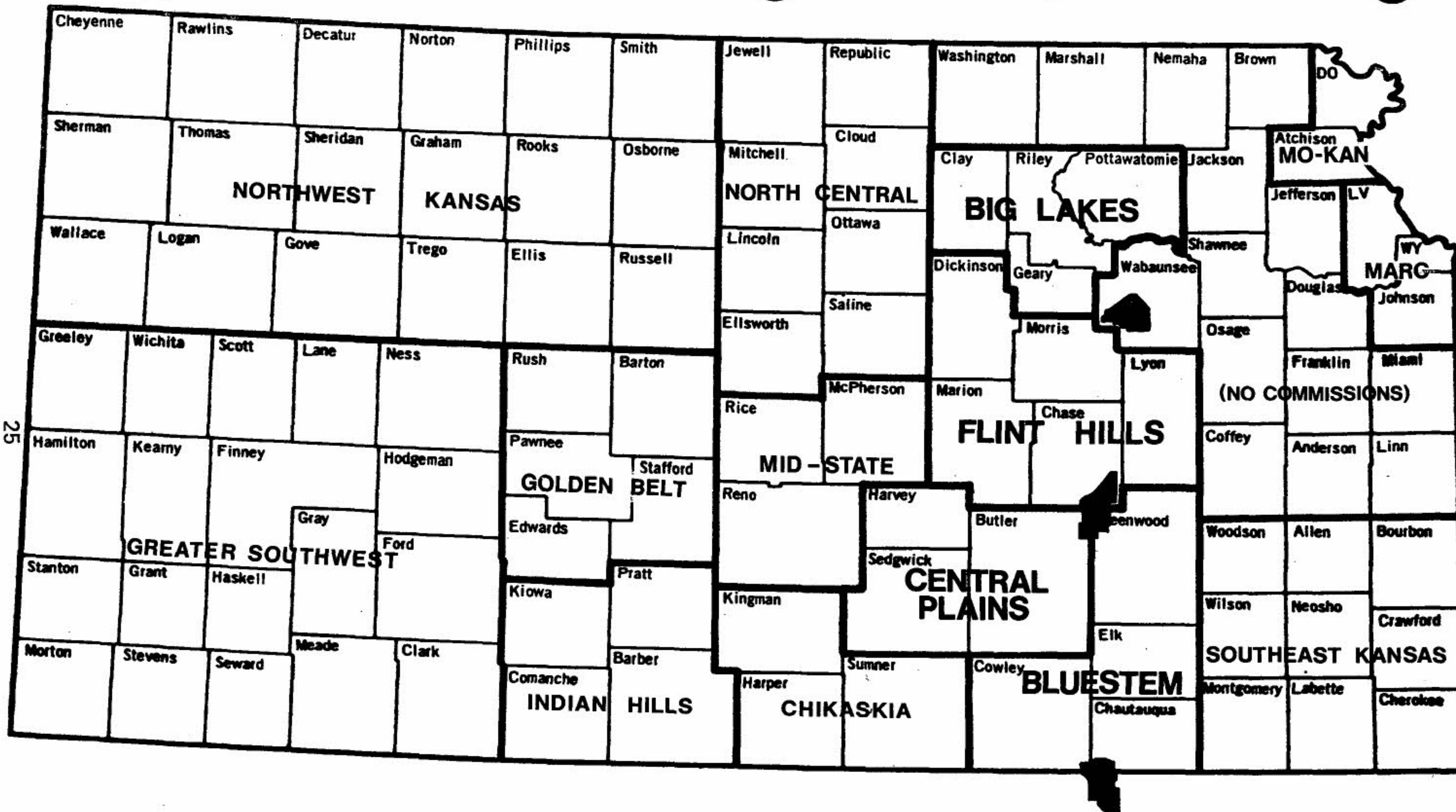


KANSAS PLANNING REGIONS

United States Department of the Interior / National Park Service

[redacted] DSC | 40081 MAY 75

ON MICROFILM



25

ORGANIZED REGIONAL PLANNING COMMISSIONS AND REGIONAL COUNCILS IN KANSAS

United States Department of the Interior / National Park Service

031 / DSC | 40016 / MAY 75

ON MICROFILM

between the two organizations is on-going. The Flint Hills RC&D has developed local goals for natural resource management and improvement of community economics. They have published a resource-based land management plan. Member counties are Chase, Dickinson, Lyon, Marion, and Morris. The RC&D comprises Chase, Lyon, Marion, and Morris Counties.

Central Plains Tri-County Planning Committee – This region takes in Butler, Harvey, and Sedgwick Counties and the Wichita SMSA. Within Sedgwick County and the city of Wichita, planning needs are primarily urban in nature. In the other two counties, at least 50 percent of the planning efforts are directed toward rural problems. Planning in the total region is therefore done on an individual county basis.

Bluestem Regional Planning Commission – This is a new commission just beginning to carry out its functions in Cowley, Elk, Chautauqua, and Greenwood Counties. (See PRAI 40,016.)

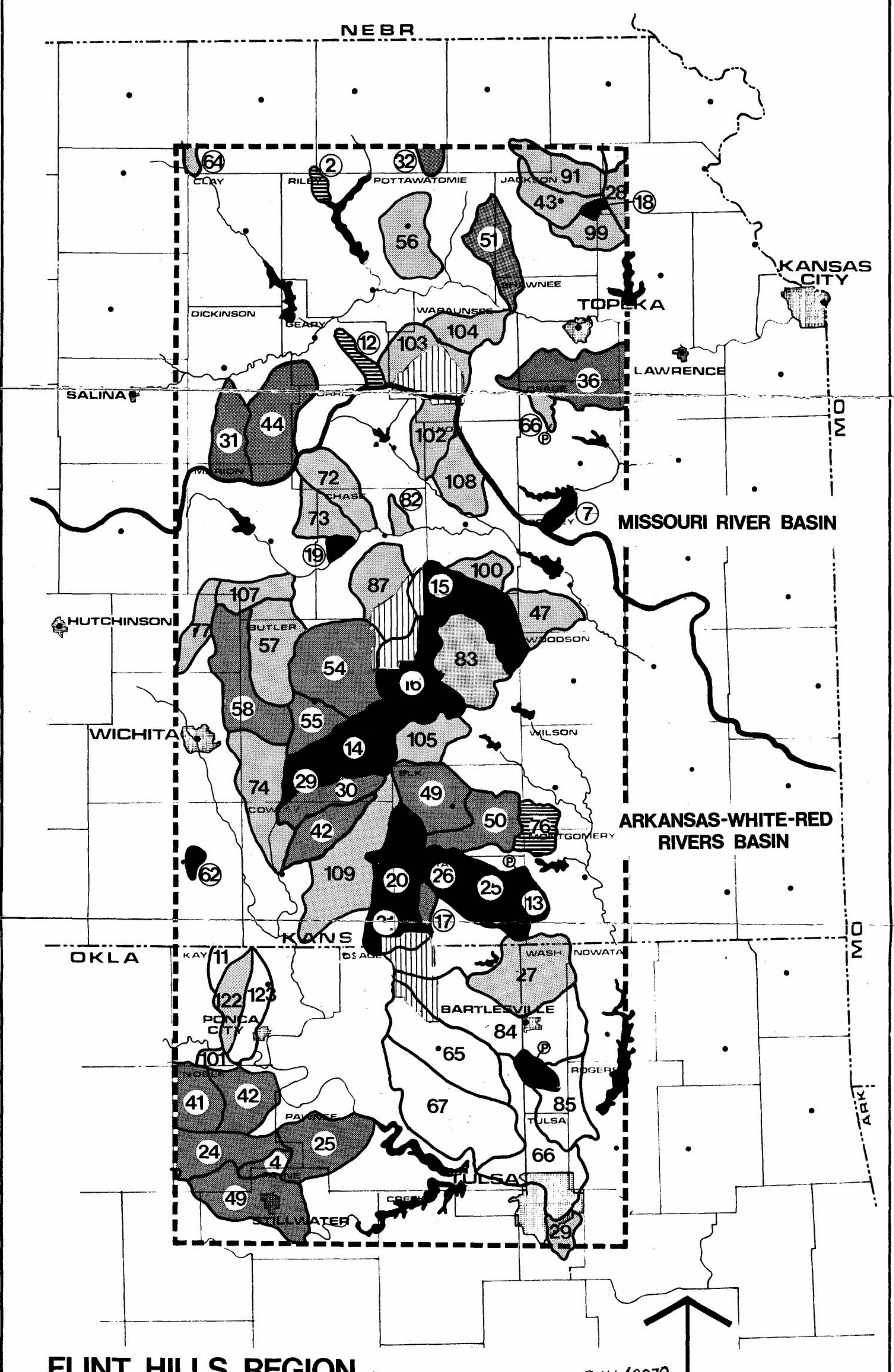
OKLAHOMA PLANNING REGIONS

Like Kansas, Oklahoma planning regions were designated in 1971 as substate regions for purposes of coordination between federal, state, and local plans and projects. The southern portion of the Flint Hills lies within Oklahoma Planning Region-06, INCOG (Indian Nations Council of Governments).

INCOG is a voluntary regional organization of local governments, comprised of Creek, Osage, and Tulsa Counties. Its purpose is to identify common regional and local issues and problems that require action on a regional basis. It is concerned with the environmental, economic, and social well-being of the region. To achieve this end, INCOG has become involved in the regional planning process. Its aim is to establish a foundation for the successful coordination of services and policies and the provision of joint or coordinated area-wide services and facilities. (See PRAI 40,080.)

SOIL CONSERVATION SERVICE

The Soil Conservation Service (SCS) has general responsibility for administering the Watershed Protection and Flood Prevention Program. SCS investigates and makes surveys of proposed small watershed projects upon application by local sponsoring organizations. SCS helps prepare work plans. It cooperates with local sponsors and state and other public agencies in installing planned works of improvement. The improvements are designed to reduce floodwater and sediment damage; to further the conservation, development, utilization, and disposal of water; to develop recreational



FLINT HILLS REGION
PRAIRIE NATIONAL PARK STUDY

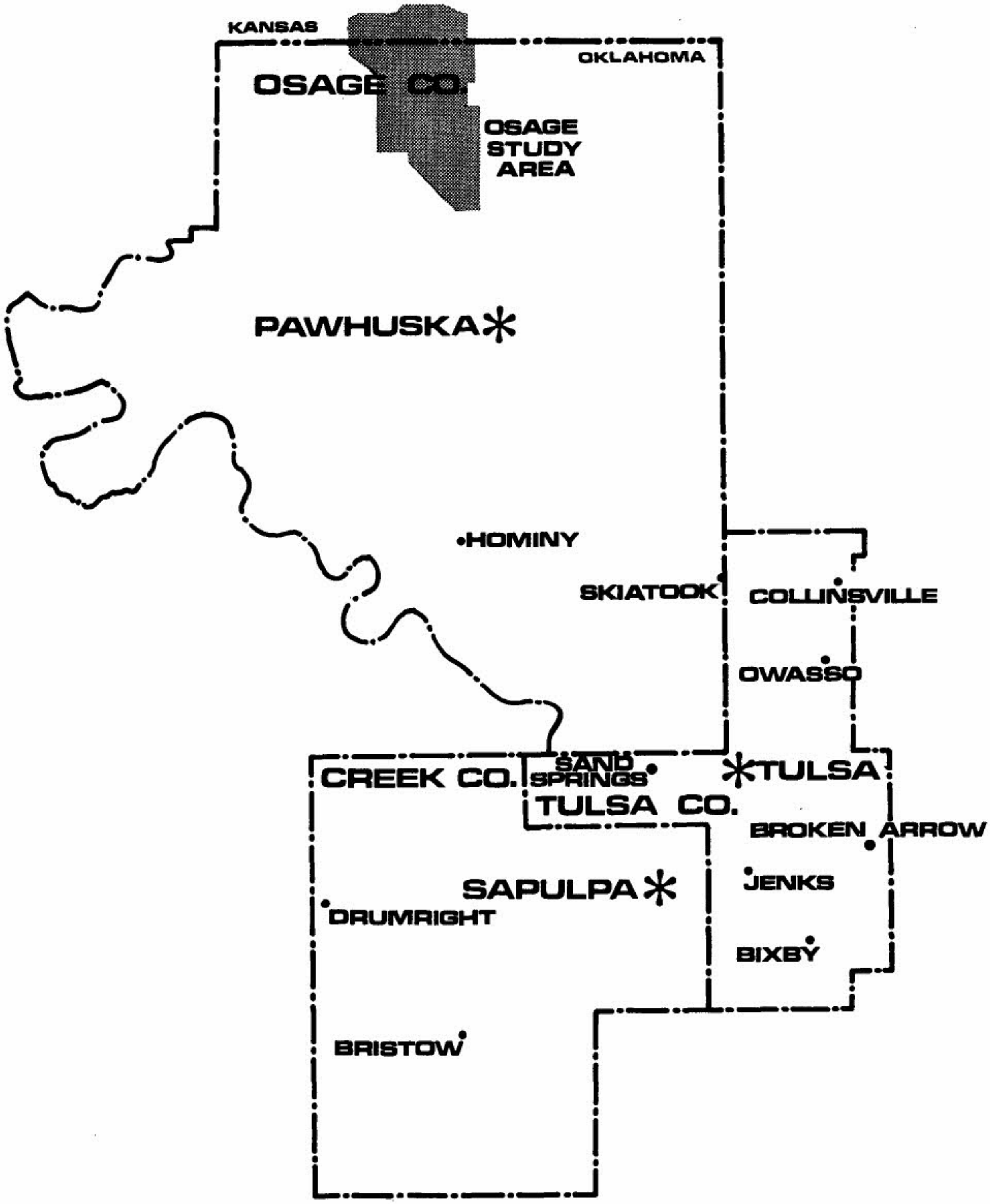
UNITED STATES DEPARTMENT OF THE INTERIOR • NATIONAL PARK SERVICE

PRAI | 40079
DSC | MAY 75

SCS WATERSHED PROJECTS

- APPLICATION RECEIVED
- APPROVED-AUTHORIZED
- UNDER CONSTRUCTION
- CONSTRUCTION COMPLETED
- TERMINATED OR NOT FEASIBLE
- Ⓟ PILOT WATERSHED

ON MICROFILM



INCOG REGION

INDIAN NATIONS COUNCIL OF GOVERNMENTS

United States Department of the Interior / National Park Service

[redacted] 031/40080
DSC / MAY 75

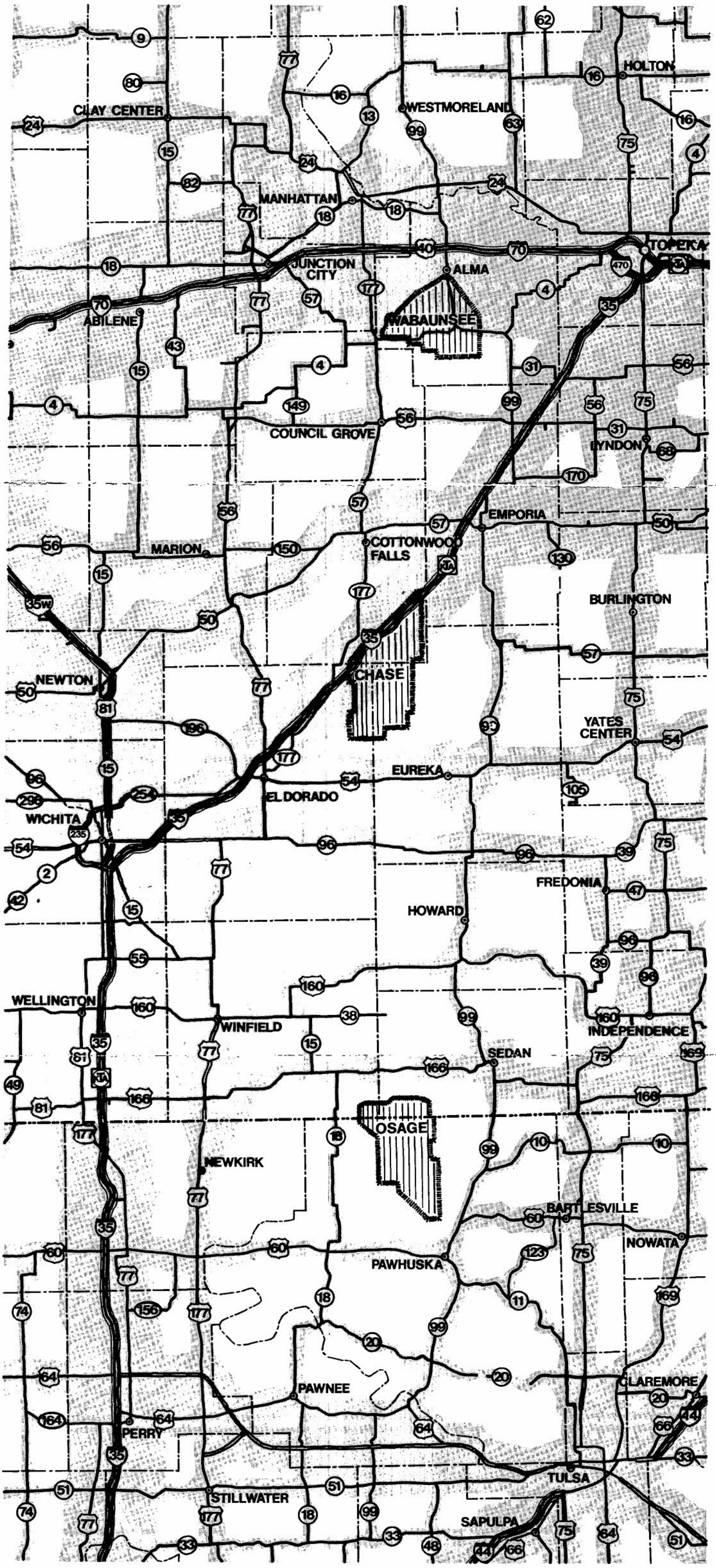
facilities; and to improve fish and wildlife habitat. (See SCS Watershed Projects, PRAI 40,079.)

TRAFFIC FLOW IN THE FLINT HILLS REGION

Traffic flow volumes were derived from the Traffic Flow Map prepared by the State Highway Commission of Kansas (1972) and the Interim Land Use Guidelines for the INCOG Region (1970). Traffic volume is represented by the width of the shaded area along each highway corridor. (See Traffic Flow map, PRAI 40,033.)

CORPS OF ENGINEERS RESERVOIRS IN THE FLINT HILLS REGION

The Corps of Engineers' Kansas City District includes the southern portion of the Missouri River basin and the northern third of the Flint Hills Region. The Tulsa District includes the Arkansas and Red River basins and the southern two-thirds of the region. The Wabaunsee study area falls within the Kansas City District, while the other two are within the Tulsa District. (See Corps of Engineers map, PRAI 40,077.)



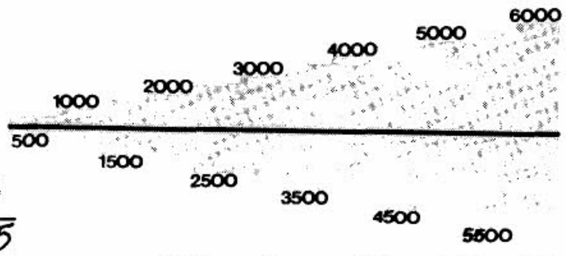
FLINT HILLS REGION

PRAIRIE NATIONAL PARK STUDY

TRAFFIC FLOW

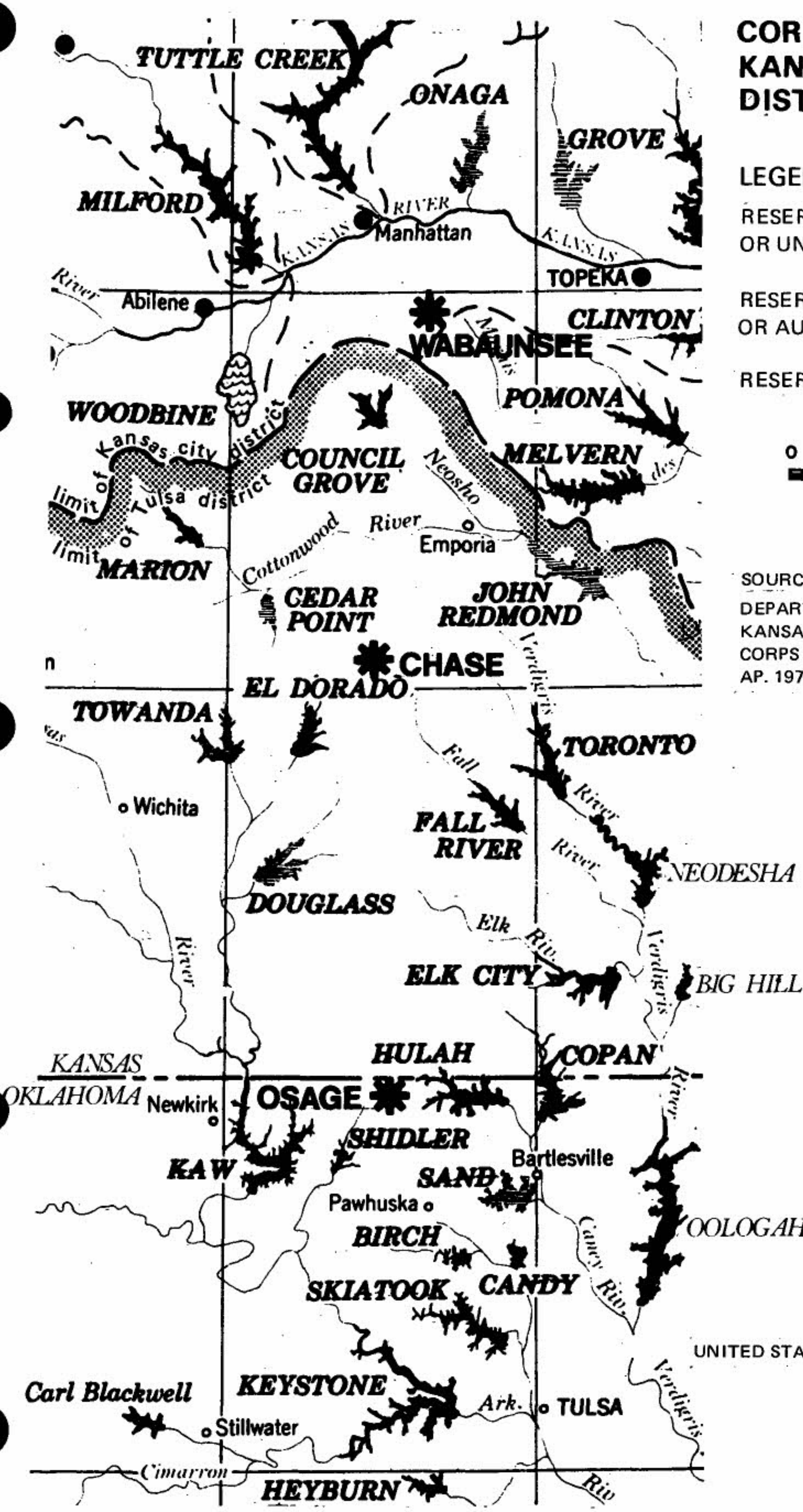
031 | 40033
DSC | MAY75

United States Department of the Interior / National Park Service



1972 annual average 24-hour traffic volume

ON MICROFILM



CORPS OF ENGINEERS KANSAS CITY AND TULSA DISTRICTS

LEGEND

RESERVOIRS COMPLETED OR UNDER CONSTRUCTION

RESERVOIRS PLANNED OR AUTHORIZED

RESERVOIRS RECOMMENDED

0 25 50

SCALE IN MILES

SOURCE:
DEPARTMENT OF THE ARMY,
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
AP. 1974

UNITED STATES DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

031
40077
DSC | JUNE 75

ON MICROFILM

BIBLIOGRAPHY

BIG LAKES REGIONAL PLANNING COMMISSION

1972 *Land Use and Open Space Plan for Pottawatomie and Riley Counties.*

CARLIN, TOM

1975 "Way Cleared for Power Giant." *Topeka Capitol Journal.* February 25 issue.

INDIAN NATIONS COUNCIL OF GOVERNMENTS

1970 *Interim Land Use Guidelines for the INCOG Region.* Tulsa, Oklahoma.

1973 *INCOG Open Space Plan Update, 2000.* Tulsa, Oklahoma.

KANSAS CORPORATION COMMISSION, TRANSPORTATION DIVISION

1972 Official Kansas state map.

1974 *A History of Railroad Construction and Abandonment Within the State of Kansas.*

KANSAS CORPORATION COMMISSION, UTILITIES DIVISION

n.d. Map of the state of Kansas showing electric transmission lines and power plants, telephone maps of Kansas counties. Butler, Chase, Chautauqua, Cowley, Greenwood, and Wabaunsee Counties. Updated monthly.

1968-1973 Electric maps of Kansas counties. Butler 1972, Chase 1968, Chautauqua 1972, Cowley 1972, Greenwood 1973, Wabaunsee 1970. Updated monthly.

1968-1969 Gasline maps of Kansas counties. Butler 1969, Chase 1969, Chautauqua 1969, Cowley 1968, Greenwood 1969, Wabaunsee 1969. Updated monthly.

KANSAS DEPARTMENT OF ECONOMIC DEVELOPMENT, AVIATION DIVISION

1972 *Kansas Airport Directive.*

KANSAS DEPARTMENT OF ECONOMIC DEVELOPMENT, PLANNING DIVISION

1968 *Outdoor Recreation Plan for Kansas.*

KANSAS DEPARTMENT OF ECONOMIC DEVELOPMENT, PLANNING DIVISION

1972a *An Outdoor Recreation Plan for Central Kansas, Report No. 38.*

1972b *An Outdoor Recreation Plan for Central Kansas,* Appendix III, Scenic Rivers and Streams Study.

1974a *Regionalism and Regional Planning in Kansas.*

1974b *Wabaunsee County Comprehensive Plan.*

KANSAS DEPARTMENT OF PLANNING AND DEVELOPMENT

1969 *Kansas Aviation Needs Study.*

KANSAS GEOLOGICAL SURVEY

1974 *Oil and Gas Pipelines and Industries in Kansas.*

KANSAS PLANNING DIVISION, FLINT HILLS REGIONAL PLANNING COMMISSION

1973 *Flint Hills Region Land Use, Economic, and Population.*

1974a *Flint Hills Region Overall Program Design.*

1974b *Flint Hills Region Open Space and Recreation Plan Inventory.*

KANSAS POWER AND LIGHT COMPANY

1973 *A New Electric Energy Center for the Kansas Power and Light Company.*

KANSAS STATE HIGHWAY DEPARTMENT, DEPARTMENT OF PLANNING AND DEVELOPMENT

n.d. *Kansas 1968 Functional Classification.*

1972a *Traffic Flow Map of Kansas.*

1972b General county highway maps for Butler, Chase, Cowley, Chautauqua, Geary, Greenwood, Lyon, and Riley Counties.

KANSAS STATE HIGHWAY DEPARTMENT, DEPARTMENT OF PLANNING AND DEVELOPMENT

1972c *Kansas 1990 Functional Classification and Population Projection, Kansas State Highway System Sufficiency Ratings.*

1974 Alignment map for proposed Southeast Kansas Toll Road.

KANSAS STATE UNIVERSITY, DEPARTMENT OF LANDSCAPE ARCHITECTURE

1973 *Kansas Flint Hills,* a resource analysis.

OKLAHOMA CORPORATION COMMISSION, UTILITIES DIVISION

1974 *Electric Utilities for Osage County, Gas Lines for Osage County, Gas Pipelines in the State of Oklahoma.*

STATE OF OKLAHOMA DEPARTMENT OF HIGHWAYS, PLANNING DIVISION

1970 *Final Project Planning Report on U.S. Highway 60, State Highway 99, and State Highway 35.*

1974a General county highway maps, Osage County.

1974b *Route Number 4 Port of Catoosa to Ponca City to Interstate 35.*

STATE OF OKLAHOMA DEPARTMENT OF TOURISM AND RECREATION, DIVISION OF STATE PARKS

n.d. *The Five Year Plan for Development.*

1974a *Design Criteria Glossary.*

1974b *Summaries of Interim Elements of Oklahoma's Statewide Comprehensive Outdoor Recreation Plan.*

U.S. ARMY, CORPS OF ENGINEERS, KANSAS CITY DISTRICT

1974 *Kansas City District Projects.*

U.S. ARMY, CORPS OF ENGINEERS, TULSA DISTRICT

1961- 1973 Various publications:. *El Dorado Lake; Kaw Lake; Skiatook Lake; Hulah Lake; Toronto Lake; Elk City Lake; Copan Lake; Fall River Lake; Birch Lake; Shidler Lake; John Redman Dam and Reservoir; Marion Dam and Reservoir; Council Grove Dam and Reservoir;* and *Tulsa District Projects, Arkansas and Red River Basins.*

U.S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

1970 "Kansas Base Map."

U.S. DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE

1961 *A "Proposed" Prairie National Park.*

1971 *Proposed Cherokee Strip Suitability/Feasibility Study.*

1974 *Proposed Prairie National Park Cultural Resources Survey.*

AGENCY CONTACTS

Contacts made within the state of Kansas:

Kansas Corporation Commission – Utilities Division
Gary Dawdy was contacted by phone and in person during February 1975 by Larry Monahan and Terry Smythe regarding the locations of telephone lines, electric transmission lines, and power plants.

Vernon Winger was contacted on February 18, 1975, in regard to the location of railroads, both existing and abandoned.

Kansas Department of Economic Development
Byron Wood and George Mathews were contacted on December 10, 1974, by Ken Krabbenhoft, Tim Tetherow, and the Land Use Team regarding planning efforts in the region.

Kansas Forestry, Fish and Game
Lee Quail was contacted by phone in regard to planned and proposed projects occurring within the region by Larry Monahan on February 12, 1975.

Kansas Highway Commission
Dave Comstock, Clyde Wood, and Terry Heidner were contacted by the Land Use Team, Ken Krabbenhoft, and Tim Tetherow in regard to existing and proposed highways. Copies of the county road maps and planned highways were obtained.

Kansas Park and Recreation Authority
Lynn Burris was contacted by Ken Krabbenhoft, Tim Tetherow, and the Land Use Team on December 10, 1975.

Wayne Herndon was contacted by Larry Monahan and Terry Smythe in regard to the location of specific recreational areas on February 6, 1975.

Soil Conservation Service
Richard Jones was contacted by phone February 12, 1975, by Larry Monahan in regard to the location of SCS projects and their status at the present time.

Contacts made within the state of Oklahoma:

Indian Nations Council of Governments
Andy Armstrong was contacted by Larry Walling and Tim Tetherow on January 30, 1975, in regard to planning by INCOG in the region.

Oklahoma Corporation Commission

Utility engineer was contacted by Larry Monahan on February 12, 1975, in regard to all utilities located in the region. This was a telephone contact. No information was gained.

Oklahoma State Wildlife Conservation Commission

Lem Dew was contacted regarding all existing and planned game refuges located in the region. This telephone conversation took place on February 12, 1975, and was made by Larry Monahan.

Oklahoma State Highway Department

Gerald Chambers was contacted by Larry Walling and Tim Tetherow concerning Oklahoma highways, both existing and planned. This interview was in person and took place on January 31, 1975.

Oklahoma State Division of Parks

Chris Delaporte and Kirk Breek were contacted in person on January 31, 1975, and by phone on February 12, 1975. These contacts were made by Larry Walling and Tim Tetherow in regard to existing and planned state parks.

Soil Conservation Service

Jimmie Frie was contacted by Larry Walling and Tim Tetherow on January 31, 1975, in regard to projects in the region, both existing and planned.

ENCLOSURE 1: WABAUNSEE STUDY AREA

A. Land Use Inventory Key to PRAI 40,046

B. Recreation Facilities (Within a 30-Mile Radius) Map Key to PRAI 40,049

A. LAND USE INVENTORY KEY TO PRAI 40,046

(The houses not specified as abandoned may be assumed to be inhabited.)

1. Transmission line: 115-kv, dc, steel towers.

2. Alma, Kansas: Population 905, modern-day agricultural town. The main intrusive element from the site is the water tower.

3. Limestone house: T-plan, 1½-story.

4.A. Limestone house: With 3 frame outbuildings.

B. Limestone house: With 7 frame outbuildings.

C. Frame house: With 10 frame outbuildings.

5. Limestone house: T-plan, 2-story, and frame house.

6. Limestone house: T-plan, 2-story, with large limestone outbuilding and stone fence in front.

7. Abandoned schoolhouse: Limestone, rectangular plan, 1-story.

8.A. Frame house: With approximately 3 outbuildings.

B. Frame house: With 2 frame outbuildings.

C. Limestone house: L-plan, 2-story, with large stone outbuilding in the rear, 5 frame outbuildings, and a tall silo.

9.A. Mill Creek campground and museum: Limestone house (rectangular plan, 2-story) with 6 frame outbuildings.

B. Limestone house: Rectangular plan, 2-story, with 3 frame outbuildings.

10.A. Limestone house: Rectangular plan, 2-story, with 10 outbuildings and stone barns.

B. Limestone house: T-plan, 2-story, with limestone barn and 12 frame outbuildings.

The community of Volland: 4 frame houses, frame general store (vacant), brick commercial building (vacant), and 5 frame outbuildings.

Five-track railroad crossing.

C. Limestone house: Rectangular plan, 2-story, with 5 frame outbuildings and a small family cemetery adjacent to the house.

11. Abandoned schoolhouse: Limestone, rectangular plan, 1-story.

12.A. House: With outbuildings ½ mile off site.

B. Two limestone houses: With 6 frame outbuildings.

C. Double trailer.

13.A. Abandoned frame house.

14. Limestone houses (2): With 2 limestone barns and 15 frame outbuildings 1/3 mile off site.

15. Abandoned schoolhouse: Limestone, rectangular plan, 1-story. Historic No. 41.

16.A. Cemetery: Templin Lutheran West.

B. Cemetery: East Templin.

17.A. Ranch: Not visible from the road.

B. Limestone house: With 4 frame outbuildings.

C. Limestone house: With 4 frame outbuildings.

Frame houses (2): With 2 frame outbuildings.

Limestone house: With 3 limestone barns.

18. Rock quarry.

19. Limestone buildings (2): With 1 frame outbuilding.

20.A. Rock quarry.

B. Rock quarry.

21. Frame house: With 3 outbuildings.

22. Abandoned frame house: With 3 outbuildings and a mobile home.

23. Alta Vista, Kansas: Population 400, modern-day agricultural community. The main intrusive element from the site is the water tower.

24.A. Frame house: With 10 frame outbuildings.

B. Frame house: With 10 frame outbuildings.

25. Cemetery: Alta Vista Cemetery.

26.A. Frame house: With 6 frame outbuildings.

B. Frame house: With 8 frame outbuildings.

C. Frame house: With 10 frame outbuildings.

D. Frame house: With frame outbuilding.

E. Frame house: With 8 frame outbuildings.

27.A. Abandoned frame house: With 3 frame outbuildings.

B. Abandoned frame house: With frame barn.

C. Abandoned frame house: With frame barn.

28. Abandoned schoolhouse: Frame, 1-room.

29.A. Frame house: With 6 frame outbuildings.

B. Frame house: With 5 frame outbuildings.

C. Frame house: With 8 frame outbuildings.

D. Frame house: With 6 frame outbuildings.

30. Abandoned frame barn.

31. Frame house: With 6 frame outbuildings.

32.A. Frame house: With 6 frame outbuildings.

B. Frame house: With 10 frame outbuildings.

C. Frame house.

33.A. Frame outbuilding.

B. Abandoned farm: Ruins of house and outbuildings.

34.A. Limestone house: T-plan, 2-story, with 2 limestone outbuildings, 12 frame outbuildings, and a mobile home.

B. Frame house: With 5 frame outbuildings.

35. Frame outbuilding.

36.A. Frame house: With 6 frame outbuildings.

B. Frame house.

37. Abandoned limestone house.

38. Abandoned schoolhouse: Limestone, with outbuilding in the rear.

39.A. Limestone house: Rectangular plan, 2-story, with 6 frame outbuildings.

B. Limestone house: With 5 outbuildings.

C. Frame house: With limestone barn and 2 frame outbuildings.

40. Abandoned limestone house: Large L-plan, limestone dairy barn; 2 limestone outbuildings; and 5 frame outbuildings.

41.A. Limestone house: L-plan, 2-story, with 5 limestone outbuildings, log outbuilding, and frame outbuilding.

B. Limestone house: With limestone barn and 5 frame outbuildings.

C. Frame house: With 4 frame outbuildings.

D. Frame house: With 5 outbuildings.

42.A. Frame house: With 8 frame outbuildings.

B. Frame house: With 4 frame outbuildings.

C. Frame house: With 4 frame outbuildings.

D. Frame house: With 9 frame outbuildings.

E. Frame house: With 6 frame outbuildings.

43. Abandoned frame house: With 7 frame outbuildings.

44.A. Frame house: With 8 frame outbuildings.

B. Frame house: With 4 frame outbuildings.

C. Frame house: With 7 frame outbuildings.

D. Frame house: With frame outbuilding.

E. Frame house.

45. Abandoned frame house: With 13 frame outbuildings.

46. Abandoned schoolhouse: Frame, 1-room.

47.A. Frame house: With 11 frame outbuildings.

Frame house: With 11 frame outbuildings.

B. Frame house: With 5 frame outbuildings.

48.A. Abandoned frame house: With 4 frame outbuildings.

B. Abandoned frame house: With 5 frame outbuildings.

49.A. Frame house: With 9 frame outbuildings.

B. Frame house: With 5 frame outbuildings.

C. Frame house: With 4 frame outbuildings.

D. Frame house: With 2 frame outbuildings.

E. Frame house: With 3 frame outbuildings.

F. Frame house: With 11 frame outbuildings.

50. Electrical substation.

51.A. Frame house: With 4 frame outbuildings.

B. Recreational dwelling: With permanent dwelling, both invisible from the road.

52.A. Pole barn: With 2 frame outbuildings.

Pole barn.

B. Abandoned frame house.

C. Frame barn.

53.A. Frame house: With 7 frame outbuildings.

B. Frame house: With 2 frame outbuildings.

54. Oil field: 7 oil storage tanks.

55.A. Frame outbuildings (2).

B. Frame outbuildings (3).

56. Frame house: With frame outbuilding.

57.A. Abandoned frame house: With 7 frame outbuildings.

B. Abandoned frame house: With 3 frame outbuildings and stone fence in good condition.

C. Abandoned frame house: With 4 frame outbuildings and planted windbreak.

58.A. Frame house: With 8 frame outbuildings.

B. Frame house: With 6 frame outbuildings.

C. Frame house: With 8 frame outbuildings and mobile home.

59. Abandoned limestone house.

60. Abandoned frame barn.

61.A. Combination limestone and frame house: With 15 frame outbuildings.

B. Limestone house: With 15 frame outbuildings.

C. Frame house: With 6 frame outbuildings.

62. Oil field: Single pump and 4 storage tanks.

63.A. Double-wide mobile home.

B. Frame house: With 2 limestone outbuildings and 4 frame outbuildings.

C. Frame houses (2): With 8 frame outbuildings.

Frame house: With 4 frame outbuildings.

64. Abandoned limestone house.

65. Limestone house: Rectangular plan, 2-story, with limestone outbuilding and 6 frame outbuildings.

66. Abandoned schoolhouse: Limestone, with limestone outbuilding and frame outbuilding.

67.A. Limestone house: With 7 frame outbuildings.

B. Frame houses (3): With 8 frame outbuildings.

68.A. Farmstead not visible from the road.

B. Brick house.

C. Frame house: Limestone veneer, with 2 frame outbuildings.

D. Frame house.

E. Combination limestone and frame house: With barn and 2 frame outbuildings.

69. Limestone house: Rectangular plan, 2-story.

70.A. Frame house: With 4 frame outbuildings.

B. Frame house: With 10 frame outbuildings.

C. Frame house: With 4 frame outbuildings and a mobile home.

D. Frame house: With 2 limestone outbuildings and 2 frame outbuildings.

71.A. Combination limestone and frame house: With barn, chicken coop, and frame outbuilding.

B. Limestone house.

C. Frame house: With 3 frame outbuildings and an orchard.

D. Limestone house: With barn.

E. Limestone house: With 3 frame outbuildings.

72. Abandoned limestone house: With 4 limestone outbuildings and 3 frame outbuildings.

73.A. Frame house: With 3 limestone outbuildings and 6 frame outbuildings.

B. Limestone house: With 4 stone buildings and 4 frame outbuildings.

C. Frame house: With 4 frame outbuildings and 2 limestone outbuildings.

74.A. Abandoned frame house: With 5 frame outbuildings.

B. Frame outbuildings (4).

C. Metal barn.

75.A. Frame house: With 2 frame outbuildings.

B. Limestone house: With 3 limestone outbuildings and 3 frame outbuildings.

Limestone barn: With stone fence.

C. Frame house: With 5 frame outbuildings.

76. Abandoned schoolhouse: Limestone, frame addition, with stone fence.

77.A. Frame barn.

B. Abandoned limestone house: With limestone outbuildings.

78. Frame house: With pole barn in the rear.

79. Frame outbuilding.

80. Limestone house: With 2 limestone outbuildings and 3 frame outbuildings.

81. Frame outbuildings (3): Small.

82. Frame house: With 2 limestone outbuildings and 2 frame outbuildings.

B. RECREATION FACILITIES (WITHIN A 30-MILE RADIUS) MAP KEY TO PRAI 40,049

43 Rest Area (Pottawatomie County)
70 Pottawatomie County State Lake Park
9 Pottawatomie County State Lake Park
69 Tuttle Creek Game Management Area
68 Tuttle Creek Game Management Area
73 Rocky Ford
54 Riley County Playground
10 Wildcat Creek Park
12 Prospect Heights Park
72 Deep Creek Fishing Area
42 Highway Rest Area (Pottawatomie County)
37 Highway Rest Area (Geary County)
38 Highway Rest Area (Geary County)
8 Diamond Springs
67 Council Grove Reservoir Game Management Area
7 Lyon County State Lake
65 Lyon County State Park
13 Alma Area
14 Lake Wabaunsee County Park
52 Alma Courthouse

ENCLOSURE 2: CHASE STUDY AREA

A. Land Use Inventory Key to PRAI 40,047

B. Recreation Facilities (Within a 30-Mile Radius) Map Key to PRAI 40,049

A. LAND USE INVENTORY KEY TO PRAI 40,047

1. Mobile home.

2.A. Oil field.

B. Oil field.

C. Oil field.

3. Frame house.

4.A. Oil field.

B. Oil field.

C. Oil field.

5. Farm complex: Not visible from the road.

6. Transmission line: 115-kv.

7. Farm complex.

8. Abandoned frame house: Rectangular plan, 2-story.

9. Frame house: Not clearly visible from the road.

10. Microwave tower.

11. Microwave tower.

12. Frame house.

13.A. Abandoned log and frame house: T-plan, 1-story, with several outbuildings.

B. Abandoned schoolhouse: Frame.

14.A. Farm complex.

B. Frame house: With 2 frame outbuildings.

15. Frame house.

16. Cemetery: High Prairie Cemetery.

17.A. Frame house.

B. Farm complex.

18.A. Frame house: With 6 frame outbuildings.

B. Frame houses (2).

19.A. Frame house: With 4 outbuildings.

B. Frame house: With 4 outbuildings.

20.A. Frame house: With 5 outbuildings.

B. Frame houses (4): With 8 other buildings.

C. Dwelling unit: With 5 outbuildings. Not easily visible from the road.

D. Dwelling unit: With outbuilding. Not visible from the road.

21. Compressor station: With large paved lot.

22. Frame houses (2): With 7 outbuildings.

Cemetery.

23. Water tower: At Interstate 70 interchange.

24.A. Oil field.

B. Oil field.

C. Oil field.

25.A. Oil field.

B. Oil field.

C. Oil field.

26.A. Oil field.

B. Oil field.

C. Oil fields.

27.A. Approximately 7 structures. Not highly visible from the road.

B. Metal outbuilding.

28. Microwave tower.

Frame house: With 4 outbuildings.

29.A. Oil field: With oil ponds, storage tanks, and maintenance sheds.

B. Oil field: With oil ponds, storage tanks, and maintenance sheds.

30. Oil field.

31.A. Limestone house: Rectangular plan, 2-story.

B. Abandoned frame house and frame store. Community of Lapland.

32.A. Frame house: With 4 frame outbuildings.

Frame house: With 5 frame outbuildings.

B. Farm complex.

33. Frame house: With frame outbuildings.

34. Abandoned frame house: With 3 outbuildings.

35. Abandoned schoolhouse: Frame, 1-room.

36. Pole barn.

37. Farm complex.

B. RECREATION FACILITIES (WITHIN A 30-MILE RADIUS) MAP KEY TO PRAI 40,049

28 Highway Rest Area (Chase County)
29 Highway Rest Area (Chase County)
4 Chase County State Lake
60 Chase County State Lake Fishing Area
86 El Dorado Reservoir Recreation Area
27 Highway Rest Area (Lyon County)
48 Lyon County Fairgrounds
26 Highway Rest Area (Lyon County)
25 Highway Rest Area (Greenwood County)
45 Greenwood County Fairgrounds

ENCLOSURE 3: OSAGE STUDY AREA

A. Land Use Inventory Key to PRAI 40,048

B. Recreation Facilities (Within a 30-Mile Radius) Map Key to PRAI 40,049

A. LAND USE INVENTORY KEY TO PRAI 40,048

1.A. Abandoned frame house: With frame outbuilding.

B. Frame house: With frame outbuilding.

2.A. Frame house: With 4 outbuildings.

B. Frame house: With 6 frame outbuildings.

3. Chapel: "Wee" Kirk in the Valley roadside chapel, frame.

4. Frame house: With 10 outbuildings.

5. Cemetery: Rock Creek Cemetery.

6. Frame outbuilding.

7. Frame outbuilding.

8.A. Frame house: With 5 frame outbuildings.

B. Frame house: With 4 frame outbuildings.

9. Frame house: With frame outbuildings.

10. Quarry.

11. Airport: Grass landing strip with metal hangar.

12. Water tower.

13. Farm complex: With 3 frame houses with approximately 12 frame outbuildings in excellent condition.

14. Pole barn: With frame outbuilding.

15. Frame house: With 2 frame outbuildings.

16.A. Oil field.

B. Oil field.

17. Frame house: With 3 frame outbuildings.

18. Frame outbuilding.

19. Cemetery: Foraker Cemetery.

20.A. Oil field.

B. Oil field.

21. Oil field.

22.A. Farm complex: Large frame house with approximately 12 outbuildings. Excellent condition.

B. Frame house.

23. Frame house: With 2 frame outbuildings.

24. Oil field.

25. Frame House: With approximately 4 outbuildings.

26. Frame house: With approximately 3 frame outbuildings.

27.A. Oil field.

B. Oil field.

28. Abandoned frame house: With 6 frame outbuildings.

29. Oil field: Approximately 12 pump jacks.

30.A. Abandoned combination limestone and frame house: L-plan, 1½-story.

B. Frame outbuilding.

31.A. Oil field.

B. Oil field.

32. Cemetery: Rosedale Cemetery.

33. Frame house: 2-story.

34. Abandoned frame house: 1-story.

35.A. Frame outbuildings (2).

B. Abandoned frame house: 2-story.

36.A. Frame house: With 5 frame outbuildings and metal Quonset building.

B. Frame house: With 5 frame outbuildings and metal Quonset building.

C. Not visible from the roads.

D. Farm complex: Frame style.

E. Frame house: With several outbuildings.

F. Farm complex: Frame style.

37.A. Frame house: With several outbuildings.

B. Frame house: With 6 frame outbuildings.

C. Frame house: T-plan, with several outbuildings, barn, and silo.

D. Barn.

E. Frame house: With 4 frame outbuildings.

Frame house: With 5 frame outbuildings.

38. Abandoned frame house: With frame outbuilding.

39.A. Farm complex: Small.

B. Farm complex.

C. Farm complex.

B. RECREATION FACILITIES (WITHIN A 30-MILE RADIUS) MAP KEY TO PRAI 40,049

11 Hulah Reservoir
12 Kaw Reservoir
13 Birch Reservoir
10 Copan Reservoir
8 Diamond Springs
47 Chautauqua County Fairgrounds
78 White Eagle State Park
82 Copan Reservoir Recreation Area
79 Osage Hills State Park
84 Birch Reservoir Recreation Area
83 Kaw Reservoir Recreation Area

ENCLOSURE 4: REGIONAL INVENTORY OF RECREATIONAL LAND USES

CORPS OF ENGINEERS RESERVOIRS

Completed	Under Construction	Planned - Authorized
Tuttle Creek	El Dorado	Onaga
Milford	Copan	Grove
Melvern	Kaw	Woodbine
John Redmond	Shidler	Cedar Point
Council Grove	Birch	Towanda
Marion	Skiatook	Douglas
Toronto	Candy	Nedosha
Elk City		Sand
Hulah		

DEPARTMENT OF THE INTERIOR
BUREAU OF SPORT FISHERIES AND WILDLIFE

John Redmond National Wildlife Refuge

STATE OF KANSAS

State Parks

Tuttle Creek
Milford Reservoir
Melvern Reservoir
John Redmond Reservoir
Council Grove Reservoir
Marion Reservoir
Toronto Reservoir
Fall River Reservoir
Elk City Reservoir
El Dorado (Under Construction)

Scenic Rivers

Smoky Hill River
Lyon Creek
Kansas River
Rock Creek
Vermillion Creek
Mill Creek
Wakarusa River
Cottonwood River
Diamond Creek
Fall River
Elk River
Caney River
Grouse Creek
Walnut River
Whitewater River
Arkansas River
Little Arkansas River

STATE OF OKLAHOMA

State Parks

Hulah Reservoir
Copan Reservoir (Under Construction)
Kaw Reservoir (Under Construction)
Shidler Reservoir (Under Construction)
Birch Reservoir (Under Construction)
Skiatook Reservoir (Under Construction)
Candy Reservoir (Under Construction)

Key to State-Owned Recreation Lands

1) Osage County State Lake
2) Shawnee County State Lake
3) Lake Shawnee County Park
4) Chase County State Park
5) Herrington City Lake
6) Geary County State Lake
7) Lyon County State Park
8) Diamond Springs
9) Pottawatomie County State Park
10) Wildcat Creek Park
11) Sand Hill Park
12) Prospect Heights Park
13) Alma Area
14) Lake Wabaunsee County Park
15) Elgin Area
16) Cowley County State Park
17) Grenola Area
18-44) Highway Rest Stops County Parks
45) Greenwood County Fairgrounds
46) Elk County Fairgrounds
47) Chautauqua County Fairgrounds
48) Lyon County Fairgrounds
49) Marion County Park and Lake
50) Sedgwick County Fairgrounds
51) Sedgwick County Zoo
52) Alma Court House
53) Brown Memorial Field
54) Riley County Fairgrounds
55) Clay County Fairgrounds
56) Clay-Wakefield Park

State Fishing and Hunting Areas

57) Pomona Reservoir Forestry, Fish and Game
58) Melvern Reservoir Forestry, Fish and Game
59) Shawnee County State Lake
60) Chase County State Lake
61) Milford Reservoir Game and Water Management
62) Milford Reservoir Game and Water Management (no. 2)
63) Geary County State Park
64) John Redmond Reservoir Game Management Area
65) Lyon County State Lake
66) Marion Reservoir Game Management Area
67) Council Grove Reservoir Game Management Area
68) Tuttle Creek Reservoir Game Management Area
69) Tuttle Creek Reservoir Game Management Area
70) Pottawatomie County State Lakes and Parks 1 and 2
71) Pottawatomie County State Lakes and Parks 1 and 2
72) Deep Creek Fishing Area
73) Rocky Ford
74) Lake Clymer State Park
75) Cowley County State Lake
76) Fall River Game Management Area
77) Toronto Game Management
78) White Eagle State Park
79) Osage Hills State Park
80) Walnut Creek Recreation Area
81) Feyodi Creek Recreation Area
82) Copan Reservoir Recreation Area
83) Kaw Reservoir Recreation Area
84) Birch Reservoir Recreation Area
85) Skiatook Reservoir Recreation Area
86) El Dorado Reservoir Recreation Area
87) Elk City Reservoir Recreation Area
88) Candy Reservoir Recreation Area

H: CULTURAL RESOURCES

CULTURAL RESOURCES

ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by

Denver Service Center
National Park Service
United States Department of the Interior

CONTENTS

INTRODUCTION

This survey of cultural resources was undertaken as part of the environmental assessment of the alternative study areas found to meet criteria for a Prairie National Park. The information contained here will in part serve to determine the relative suitability and feasibility of the three sites for designation as a Prairie National Park.

The purpose of this report is to develop cultural data at three different levels:

The response to the prairie region in American cultural evolution.

The cultural significance of the Flint Hills in the tallgrass-prairie region.

Identification of specific cultural resources within or adjacent to the three alternative sites.

To complete this project, basic research was done in libraries and archives at the University of Kansas, the Kansas Historical Society, Kansas State University, the University of Oklahoma, and the Oklahoma State Historical Society. Due to time constraints, libraries at Emporia State College and Wichita State University were not visited. Local private and public museums were inspected. Upon completion of this background research, the research historian's field time was utilized driving and hiking to inspect extant cultural sites.

At this point, a word of caution should be interjected. The sites discussed in this survey in no way comprise the total number of cultural resources located within the three study areas. Occasionally it was impossible to inspect certain sites due to sketchy descriptions in source material, impassable roads, hard-to-locate sites, or overt warnings not to trespass. This report does provide an overview of cultural resources; however, subsequent in-depth research may turn up other items that might merit consideration.

THE PRAIRIE REGION

While I know the standard claim is that Yosemite, Niagara Falls, the Upper Yellowstone and the like afford the greatest natural shows, I am not so sure but that the Prairies and Plains last longer, fill the esthetic sense fuller, precede all the rest and make North America's characteristic landscape.

— Walt Whitman

It's nearly gone and we still don't know it or understand it. Our learned scientific texts speak of the prairie in the past tense — content to inventory its lush grass species and its wildlife skilled in adaptation to all but man. Historians have analyzed its economic and spatial meaning to our nation; a few courageous ones have entered essays on its role in the American experience. But it has been mainly the poets and novelists — the Carl Sandburgs and Willa Cathers — who have tried to face the prairie and make it comfortable for the human spirit.

Barren of trees, the prairie was anathema to an agrarian people derived from the forests of western Europe and the Atlantic shore, where trees were the only measure of rich soil. Stephen Long had told pioneers that the prairie was desert, and he predicted their reaction to it very well. In their rush across the continent to gold and tree-symboled

farms, the settlers passed the grasslands by, merely enduring the crossing. But to a man they knew they had confronted a land of special qualities; their journal entries of the crossing stretch the limits of language and invective in their efforts to describe it.

Like an ocean breaker, the wave of settlers crashed against the California-Oregon shore and eddied back, spending itself last in the great North American Prairie. Only desperate men – mostly poor European peasants – were willing to content themselves with this treeless land, thought to be so marginal in value that it had to be given away.

Finally they did come to pit themselves against the strange prairie environment, and then they found it savage as well. Their durable bodies and spirits were strained and sometimes broken, but they persevered. They plowed and planted it, fenced and grazed it. They worked the soil to create a powerful food skeleton for the body of a great industrial society. Their story is not simple history, however, for the confrontation is not over. Even today their children's children's children are learning the bounty and the penalties of the prairie.

We have read the prairie wrong. It wasn't that there were no trees – although that alone should have made us careful in our claim and care of it. We made a superficial judgment, our eyes seeing only what they were accustomed to see, and understanding only in terms of past experience. But any of us could have looked more closely. We could have seen the trees clinging to watercourses; the buffalo trails worn deep to wallows and streams; the Indians who roamed but settled only tentatively and farmed only the river bottoms. We could have considered the impact of grasses, whose root network required a new invention to break them and even then left a generation of old, bent men to hobble down sunburnt, small-town streets. We could have tasted blowing topsoil and understood the end result of the continental climate and the plow. We would have heard the weeping of women, worn out by loneliness and withered by wind. We could still count the lives lost to lightning, wind, cloudburst, and blizzard. We could have read the clear vast sky, and sensed its closeness to the sun. We could have known this was a different land – made so not only by its poor tree cover, but by a complex and marvelously unique network of interdependent qualities – found on earth so seldom that we did not, do not, understand.

The prairie is not past tense, because it is not only grass or streams, but also rain and wind and altitude and the continental interior. And Americans are coming, slowly, to understand. Led by poets, some can see the seductive beauty of soft-grassed mornings when meadowlarks sing, sense the wandering drive of hot wind rattling the leaves of cottonwood, know the joy of snug shelter when black clouds streak and howl across the sky, sense renewal in the sheeting water – river or rain. Maybe we will come to understand ourselves and this environment in a new and never before way, in a way that could make both richer than ever thought.

THE FLINT HILLS

The Flint Hills of eastern Kansas and northern Oklahoma, sometimes called the bluestem pasture region, is the most extensive remaining grassland of the once vast tallgrass prairie of North America. The region comprises a relatively narrow strip extending almost the full north/south length of eastern Kansas. In the north, the Flint Hills parallel the Blue River in Pottawatomie County. In the south, they blend into the grazing and oil country of northern Oklahoma. For the most part, the hills remain remarkably free from the effects of the plow, owing their immunity to the prevalence of flinty lime rock and the thin soils. The parent rock is found in solid strata of varying thicknesses, which parallel one another at different levels. These strata are so close together that one may frequently count five or six distinct outcroppings on a single hillside.

By contrast, the river and creek bottoms adjacent to the hills welcome agriculture. Here, for thousands of years, lush grasses have grown, ripened, and decayed, creating the humus that blackens the soil; lime constantly erodes from the surrounding hills to sweeten it.

Early explorers and settlers came away from the Flint Hills with a rather poor opinion of its potential for settlement. Coming from the East, where the terrain was covered with timber and grass and where rain fell regularly and in good quantity, these people took a dim view of the rolling prairie country, where from the top of nearly every hill was an almost limitless view of the indigenous tall grass.

Yet, the Flint Hills region has provided a place of habitation for diverse peoples. Ancestors of the plains Indians may have arrived some 10,000 years ago. (Archaeological resources will be treated in a separate survey.) Indians, as well as later settlers, coped with and tried to modify this isolated and frequently harsh environment. Initial European penetration probably occurred in the early 1540s, when the Spaniard Coronado led an expedition to Quivira (present-day central Kansas) futilely searching for the fabled seven cities of Cibola. Other French and Spanish expeditions crisscrossed this region in the 17th and 18th centuries, seeking to exploit the Indian trade. Other than personal accounts and maps, no physical sites remain extant to denote these early incursions.

Early in the 19th century, the federal government, wishing to strengthen its claims on this region, commissioned several military expeditions to explore the Rocky Mountain

area. Zebulon M. Pike and Stephen Long, two individuals who had traversed the plains, uttered few positive words concerning its economic future. One of the best publicized ventures involved John C. Fremont, the "Pathfinder," who crossed the Flint Hills in the 1840s. These early explorers tagged this region and the vast, featureless plains to the west the "Great American Desert," not realizing their economic potential.

As these explorers and others went West, the confrontation between Indians and whites increased. For instance, 4 years after the Missourian William Becknell led the first successful packtrain to Santa Fe from St. Louis in 1821, the federal government signed a co-existence pact with the Osage tribe to ensure safety for future commercial ventures. From that point onward, the future of the lifestyle of the plains Indians was intertwined with the arrival of Americans and foreign immigrants who poured into, but mostly through, this region in the 1840s and 1850s.

Meanwhile, numerous eastern woodland tribes were relocated in the unsettled lands west of the Missouri River, now Kansas and Oklahoma. In 1846 the Pottawatomies were moved to a 30-square-mile tract of land west of present-day Topeka. The reservation included portions of Pottawatomie, Jackson, and Wabaunsee Counties. Around that same time, Kaw Indians moved to a small reservation near Council Grove, in the heart of the Flint Hills. Although relations between whites and Indians remained fairly peaceful in the Flint Hills region, fierce warfare broke out between these two antithetical cultures further west.

Most of the first pioneers, like the earlier explorers, were merely passing through the prairie, lured by destinations and promises west of the "Great American Desert." Immigrants skirted the Flint Hills' northern edge as they followed the California-Oregon Trail. More directly involved was the Santa Fe Trail, which bisected the Flint Hills. Council Grove was first a key way-point on the Santa Fe Trail, and later a major community serving agricultural needs of the northern Flint Hills. Merchants, adventurers, and settlers flowed through this tiny frontier community, often stopping to resupply and to leave messages for eastern kinfolk. In 1853, the United States established Fort Riley on the northwest edge of the Flint Hills to protect the Oregon-California and Santa Fe Trails.

Except for Council Grove, the Flint Hills region was largely quiet and forgotten prior to the Civil War. Most of the slaver/free-stater controversy occurred east of this region. The northern area of Wabaunsee County witnessed some action in the undeclared conflict between "free staters" and "slave staters." At the tiny community of Wabaunsee, the free-state element organized the Beecher Rifle and Bible Church, a rallying point for the anti-slavery element. This congregation provided irregular forces that helped defeat the Missouri incursions that threatened to make Kansas Territory a slave state.

Roughly half of the Flint Hills counties in Kansas were organized as political units prior to the Civil War, but populations grew slowly for a number of years. Not until the post-bellum period when settlers took up free homesteads did large-scale prairie settlement truly commence. For example, in 1865, 4,472 wagons, 5,197 people, 1,267 horses, 6,452 mules, 38,000 oxen, 112 carriages, and 13,000 tons of freight crossed a Santa Fe Trail tollbridge near Council Grove.

Also shortly after the Civil War, ranchers from the Southwest, where grass sometimes is sparse in midsummer, "discovered" the Flint Hills and their beef-producing capabilities. In 1867, the first longhorn herds were driven over the Chisholm Trail to Kansas railheads and put to pasture for the summer in the vast grasslands of the Flint Hills. They have been coming ever since, only today the cattle are shipped in by train or truck to Kansas. Since those early days, the Flint Hills have rarely been vacant in the summer. Texans, so often faced by drought, found a profitable combination in this land on the edge of the Cornbelt, too full of flint and limestone for any plow, but producing grass with remarkable beef-building qualities. Here the centuries-old rock had sweetened the soil so that the bluestem often stood higher than a man's head. And today it has changed only by the addition of scattered windmills, ponds, roads, fences, and cropland.

However, in 1867 cattle was not yet king in this country. Through the 1870s agricultural uses in eastern Kansas were diversified – general subsistence farming, raising corn for livestock, breeding of fine stock, and grazing transient stock. In fact, this latter use gave rise to the oft-romanticized conflict between cowman and farmer.

Drought, grasshopper infestations, and economic conditions contributed to a decline in farming while other conditions favored the cattle industry, precipitating a livestock boom in the 1880s. The region trended toward raising fine cattle for several reasons: The fairly rugged topography and shallow soils were not conducive to raising crops; and the eastern demand for beef increased rapidly in the 1870s and 1880s. At first, this demand was satisfied by longhorns driven north from Texas to the Kansas railheads of Abilene, Hutchinson, and Dodge City. Later, it was found that the Flint Hills could support a beef industry, and since the late 19th century, the cattle industry has been the region's principal economic activity. Other highly significant changes included the disappearance of open range, the assemblage of large ranches, and the introduction of barbed wire.

Unlike many homesteaded areas further west, the Flint Hills never became home to foreign immigrants. The most intensive aggregation (Germans) settled in central Wabaunsee County around Alma, where they fostered a distinctive stone architecture. To the south, smaller numbers of Germans and Swedes settled in other Flint Hills counties. A small French enclave lived in Chase County, not far from Cottonwood Falls. The Flint Hills are populated with people of largely Anglo-Saxon background, great individuality, and a passion for the land and cattle.

LAST CHANCE STORE – Served to resupply westward settlers; now an antique store. Part of the Council Grove Historic District and listed on the National Register.

OLD KAW MISSION, 1850 – Used as hotel, school, Indian agency. Now a museum. Part of Council Grove Historic District and listed on the National Register.

FARMERS AND DROVERS BANK, COUNCIL GROVE – Listed on the National Register.

COUNCIL GROVE NATIONAL BANK, 1887 – Listed on the National Register.

BEECHER BIBLE AND RIFLE CHURCH, WABAUNSEE – Listed on the National Register.

In the 20th century, population growth in the Flint Hills region has declined. Farmers have sold out to large landholding ranchers, especially in the Chase and Osage areas. The oil industry has not picked up much of the employment slack because once the wells are drilled, few workers are needed. As one travels through this region, neglected cemeteries, vacated schools, and abandoned farms and townsites meet the eye. Rural communities and hamlets reveal the long-term ravages of reduced commercial patronage. Improved roads have lured local customers to larger cities some miles distant. Regional trading centers like Manhattan, Topeka, Emporia, Wichita, El Dorado, Ponca City, and Pawhuska have profited at the expense of small rural communities like Alma, Alta Vista, Bazaar, Matfield Green, Cedar Vale, Foraker, Elgin, and Hewins.

Today the Flint Hills are still considered cattle country, and the economic and land-use patterns are much the same as those that emerged in the late 1800s. The Flint Hills region is the nation's largest commercial grazing area for grass-fattening transient cattle. This process may follow several different patterns: the owner-producer of transient cattle may finish his cattle on leased pasture; the pastureman may buy the cattle and finish the herd; the cattleman may own both a southwestern ranch for production and a Flint Hills ranch for finishing; or a middleman may own only the cattle, relying on the southwestern producer and the Flint Hills pastureman for the essential land resource.

Another function of the Flint Hills is that of maturing young cattle by roughing through the winter. The region still serves as a breeding area for thoroughbred stock. More recently, feed lot finishing has become common.

J.C. Mohler, for 35 years the Secretary of the Kansas Board of Agriculture, said this of the Flint Hills:

> To properly see and fully appreciate the hills and the marvelous views one must leave the highway and get far back in the vast expanse of the hills. There one finds vistas of utter loveliness.
>
> The fascination of the Blue Stem Hills lies not only in their rugged, broken terrain, but in the overwhelming opulence of a fertile land that stretches to the far horizons. Grass, grass, oceans of grass, with lone elms and clustered trees dotting the varied landscape and a profusion of wild flowers that lend color to enchantment. Back in the recesses of the hills, where no signs of habitation are visible, one feels far removed from the dross of civilization and may find that peace that passeth understanding, while from the summit of a majestic height there is unfolded a panorama of indescribable beauty, the regal expanse of luxuriant blue stem, tree fringed, streams, of valleys checkered with crops, imposing ranch headquarters of enduring native stone, and distant villages that nestle among the hills as though they were a part and parcel of nature's artistry.

CHEROKEE STRIP

Southwest of the Flint Hills is another prairie region steeped in folklore and rich in cultural resources. This area witnessed the last great homesteading rush on prairie land. Captain F.H. Hardie of Troop G, 3rd Cavalry, viewed the event on September 16, 1893, and reported:

> My men were posted out in front at a distance from each other of about 500 yards, with orders to keep back the crowd until the proper time, to promptly repeat the signal for starting by firing their carbines in the air.
>
> The people, as the time for starting drew near, were strung up with excitement and eagerness. At about four minutes before the starting time some one, either accidentally or on purpose, discharged a pistol in the crowd of horsemen near the railroad bridge, which started them. Seeing quickly it was impossible to stop them, I quickly fired my pistol, which was answered along the line promptly, so that the start was practically simultaneous.
>
> The killing of three or four would not have stopped the avalanche of people in their mad rush.

Thus an Army officer at the wild scene near Arkansas City, an entry point to the Cherokee Strip, described the furious start of the greatest organized land rush in the country's history – and one of the last. The significance of this event does not rest with a mere listing of superlatives, however, but rather as a milestone: With the close of the land-runs peculiar to the Kansas/Oklahoma region, the United States for the first time in over 250 years was left without a real frontier. The pioneer movement swept the land from east to west, then doubled back to plug the gaps that remained at mid-continent.

Historically, Cherokee Strip was the name applied to a narrow band of land less than 3 miles wide, left over after the southern boundary of the Kansas Territory was adjusted northward in 1854. Cherokee Outlet lay south of the strip in Indian Territory, later the state of Oklahoma. This land was deeded to the Cherokees in 1828, following their resettlement in eastern Oklahoma, as a perpetual access corridor to the buffalo-hunting grounds to the west. Eventually, the strip was homesteaded and lost its individuality, but the term continued to be applied to the old outlet lands, and this usage persists today.

The Cherokees who had been forcibly displaced from their ancestral lands east of the Mississippi earlier in the century were awarded hunting rights in this area and once

more found themselves squarely in the path of a new generation of white landseekers. First came the cattlemen seeking grazing lands for their expanding herds, as well as convenient access to existing railheads; leasing arrangements satisfied their needs. The homesteader who followed demanded different arrangements. As he saw it, the possession of the land was his right; and to tame the land was his obsession. Prompted by political and economic pressures, the Congress was forced to legislate payment to the Cherokees for their rights to the land, and to open the strip to settlement by the land-rush method.

The celebrated rush occurred on September 16, 1893. Essentially then, this date dramatized the "end of the frontier," a term first used in the census of 1890.

The prairie was – and still is – a harsh environment. Drought, insects, never-ending wind, and howling blizzards were facts of life that had to be reckoned with; many could not do so. As many as half of the 100,000 who made the rush, it has been estimated, had moved on before the end of a decade. Yet, with buffalo chips for fuel and sod houses for shelter, enough persevered: Their story – inextricably interwoven with that of the Indian, soldier, and cowboy – should be told on the land for which they struggled.

As to historic sites in the Cherokee Strip region, there are dozens of highway markers and local museums, but very few intact sites. Those few with particular relevance to the prairie are as follows:

Chilocco Indian school lands, in Kay County, Oklahoma. The school, dating from 1884, was one of several boarding schools established by the government to provide vocational/agricultural training for Indian students. Remaining are several structures, plus the cemetery, which were extant in 1893. Since this was a vantage point in 1893 for observers from Arkansas City, Kansas, the point of greatest influx, many of the familiar historic photos of the run were taken from this site. The school and grounds are presently owned and operated by the Bureau of Indian Affairs.

Impressive Chisholm Trail remains, lying in uncultivated pastureland south of Caldwell, Kansas, a cattle shipping point of the 1880s. The integrity and scope of this site is outstanding. Included is the outline of cattle pens, the railroad bed, the site of the Last Chance Saloon, and the grooves of the trail itself.

A genuine homesteader's sod house, 5 miles north of Cleo Springs, Oklahoma, in state ownership, with potential for expansion into a completely restored 160-acre Cherokee Strip homestead.

Fort Supply, in western Oklahoma, now in use as a state mental hospital, but with several structures surviving from the hectic military period of 1868-1893.

Because of its strategic location near the most significant registration and run sites, and because of the wealth of artifacts assembled on local initiative, the Cherokee Strip Living Museum at Arkansas City deserves special attention.

WABAUNSEE STUDY AREA

This study area is located entirely within Wabaunsee County, one of the initial 33 Kansas counties created in the late 1850s. Although first named Richardson, the county was later renamed by residents to honor a local Indian chief. Settlement began in 1853-54, but the population increased more rapidly after the Civil War. The Germans arrived in the late 1860s, founding Alma and settling along the west branch of Mill Creek. Alma became the county seat in 1866. One year later an enterprising citizen built the Alma Hotel. According to an early source, "The House contains upward of twenty rooms and a large and pleasant dining room where the wants of the inner man are well cared for. . . ." By the 1880s, the Atchison, Topeka and Santa Fe Railroad linked Burlingame and Alma. Some years later, the Chicago, Rock Island and Pacific entered the county from the northeast to connect Alma and Alta Vista.

When brine water was discovered near Alma, the production of quality salt became an important local industry. Stone quarrying also assumed major proportions in central Wabaunsee County. Fine limestone was employed for building purposes, lime and cement, rail ballast, and bridge supports. Later cattle grazing became a major activity in this area; shipping points developed at Alma, Volland, and Alta Vista.

Population grew quickly between 1870 and the 1880s – from 3,000 to over 8,700. It rose to 12,700 by 1910, but has since dropped to less than 7,000 in 1970.

Alma is characterized by a remarkable, attractive collection of public, commercial, and residential buildings (some of which might qualify for National Register status). An unusual array of fine limestone farm structures extends along Mill Creek and the northwest edge of the study area. This outstanding historic architecture extends into the Wabaunsee study area along the bottomlands of Illinois Creek.

ST. JOHN'S LUTHERAN CHURCH, ALMA – Stonework done by Swedish and German craftsmen in late 19th century.

HOLY FAMILY CATHOLIC CHURCH, ALMA, 1874 – Remodeled in 1899

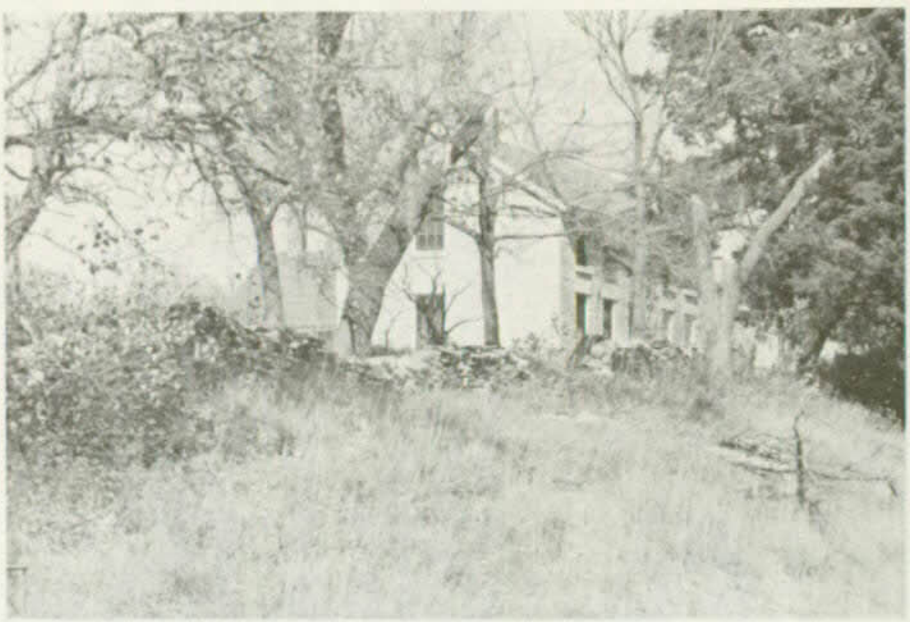
UNITED CHURCH OF CHRIST, ALMA, 1897.

SCHROEDER HOUSE, ALMA, 1888.

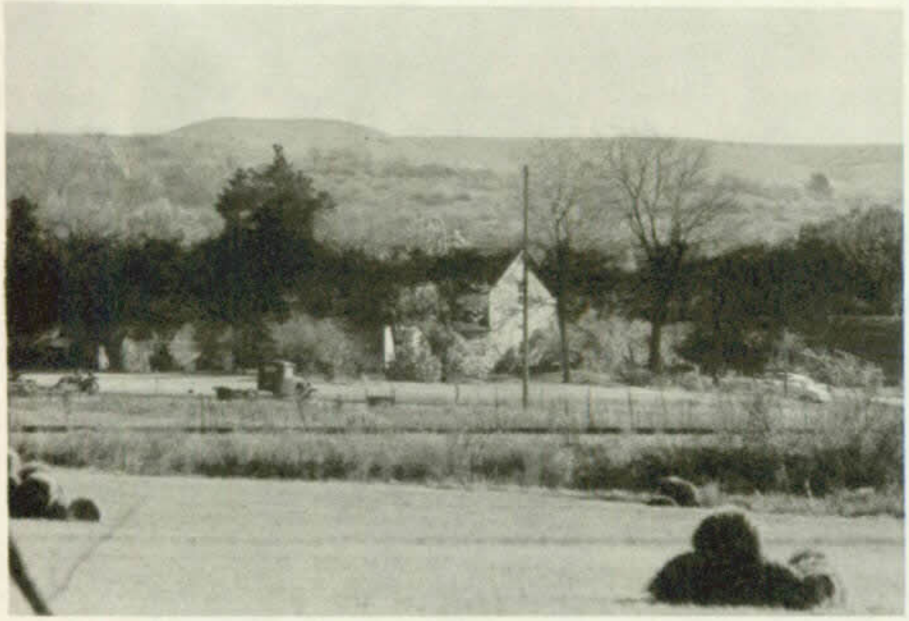
ALMA HOTEL.

PALENSKE HALL, ALMA – Former bank building with apartment above, also used as a saloon.

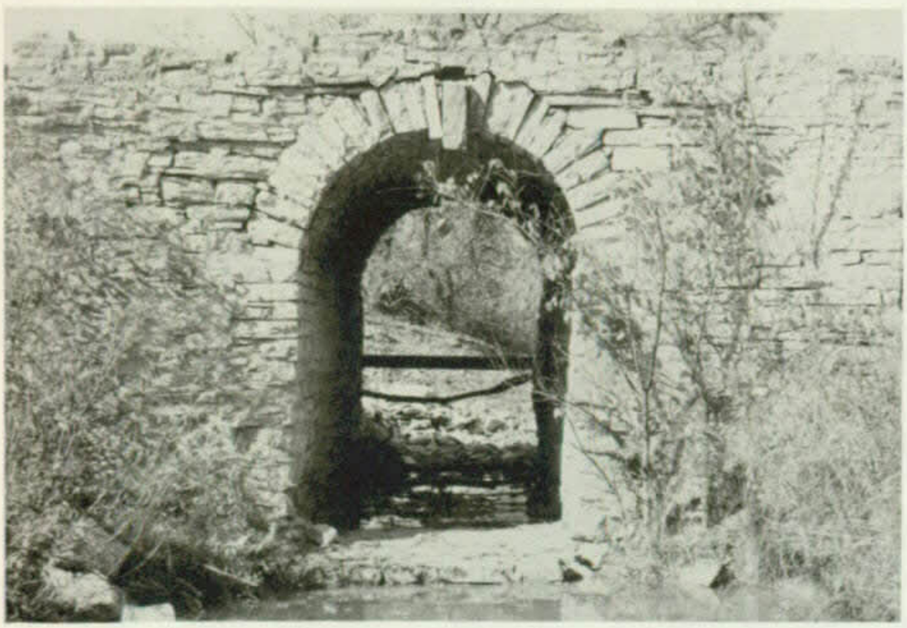
FARMHOUSE ALONG MILL CREEK IN T12S, R10E, SECTION 30.



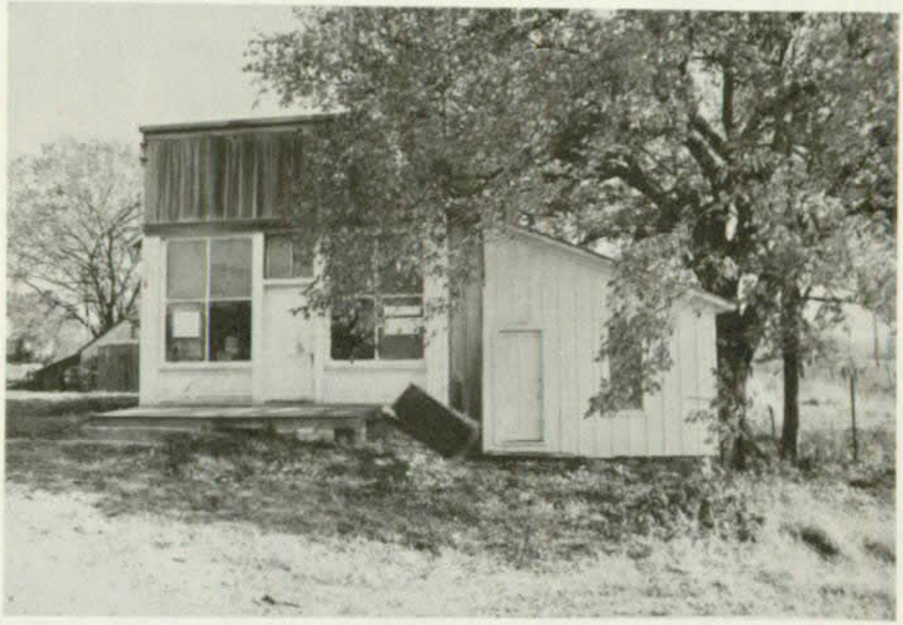
FARMHOUSE ALONG MILL CREEK IN T12S, R9E, SECTION 25 – Large stone outbuilding.



LOWELL THIERER FARM ALONG MILL CREEK IN T13S, R9E, SECTION 2 – Owner-operated private museum on premises.



STONE BRIDGE ON MILL CREEK ROAD, T13S, R9E, SECTION 3 – An example of prevalent limestone bridge craftsmanship throughout the Flint Hills.



KRATZER BROTHERS STORE IN VOLLAND ALONG MILL CREEK IN R13S, R9E, SECTION 3 – First opened in 1892. Kratzer Brothers took over in 1902 and operated until 1913; now closed.

FARMHOUSE ALONG MILL CREEK IN T12S, R9E, SECTION 25.

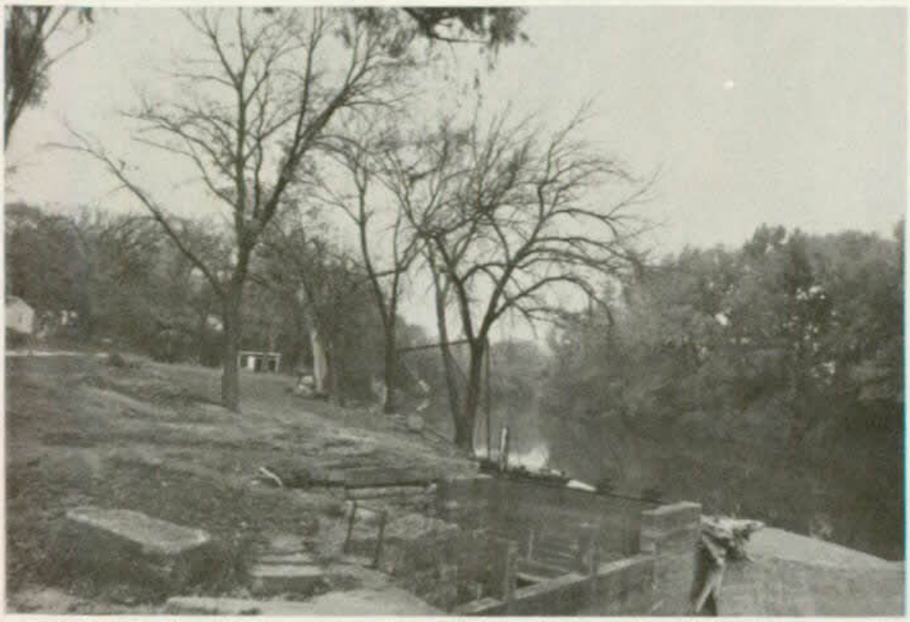
FARM ALONG ILLINOIS CREEK IN T13S, R10E, SECTION 35 –
Several stone outbuildings and a log structure.

UNOCCUPIED FARM ALONG ILLINOIS CREEK IN T13S, R10E, SECTION 6.

CHASE STUDY AREA

Roughly half of this study area lies in Chase County, and the remainder in Greenwood and Butler Counties. Chase County was founded in 1859 and named for Salmon P. Chase, a U.S. Senator and Supreme Court Chief Justice. Early settlers laid out the Cottonwood Falls townsite in 1857. A grist mill began operating in 1859, and although milling terminated in 1913, the structure remained intact until 1934; the ruins can be seen today from Kansas 177. Despite many appeals from community boosters in Cottonwood Falls, the Santa Fe Railroad laid its track on the north side of the Cottonwood River, causing the rapid development of Strong City. The local cattle-shipping industry began once the Santa Fe reached the area. Since the railway did not come to Cottonwood Falls, a lively rivalry developed between it and nearby Strong City. Due to its location as the county seat, Cottonwood Falls grew slightly larger. In the early 1870s a new limestone court house was constructed, still in use a century later. Large limestone quarries near Cottonwood Falls furnished building material for numerous projects throughout the nation. Barney Lantry and Sons provided the principal quarrying business.

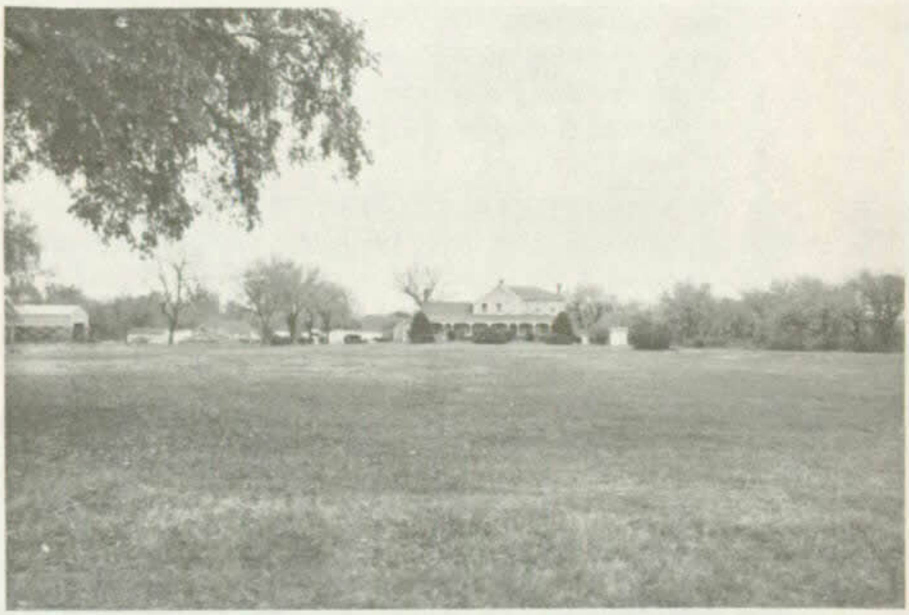
Once the railroad was completed to Cottonwood Station (Strong City) in 1872, local demand rose for rapid transit between the two communities. Five years later, a



MILL RUINS ON COTTONWOOD RIVER IN COTTONWOOD FALLS – Erected 1859, destroyed 1934.

CHASE COUNTY COURT HOUSE, 1872, IN COTTONWOOD FALLS – Listed on National Register; the oldest operative court house in Kansas.

SPRING HILL FARM, 3 MILES NORTH OF STRONG CITY, 1881 – Listed on the National Register.



S.N. WOOD HOUSE, ½ MILE EAST OF COTTONWOOD FALLS – Listed on the National Register.

horse-drawn street railway began conveying passengers between the Chase County court house and the Santa Fe depot in Strong City. Later this system reached the Catholic church, a total distance of 2 miles. The quaint public transportation line ran until 1917 when it was converted to a gasoline-powered car, but the company ceased business less than 2 years later.

Several miles south of Cottonwood Falls, the tiny community of Bazaar developed in the late 1850s. The original townsite was abandoned for a new one closer to the railroad station on the Santa Fe line. Steady progress occurred in the 1870s and 1880s, and by 1887, the railroad arrived. Bazaar became the largest cattle shipping point in Kansas as 1,800 to 2,000 cattle cars moved out each autumn. Industrious citizens built a Methodist church and several businesses in Bazaar. The old Emporia-El Dorado State Road (1861) generally followed present-day Kansas 177 below Matfield Green northward to Bazaar, then northeast toward Emporia. A further impetus to local growth was the advent of foreign investment capital. According to one Kansas historian (R. Richmond), a limited British influence appeared in Chase County when younger sons from titled families became cattle ranchers in this area.

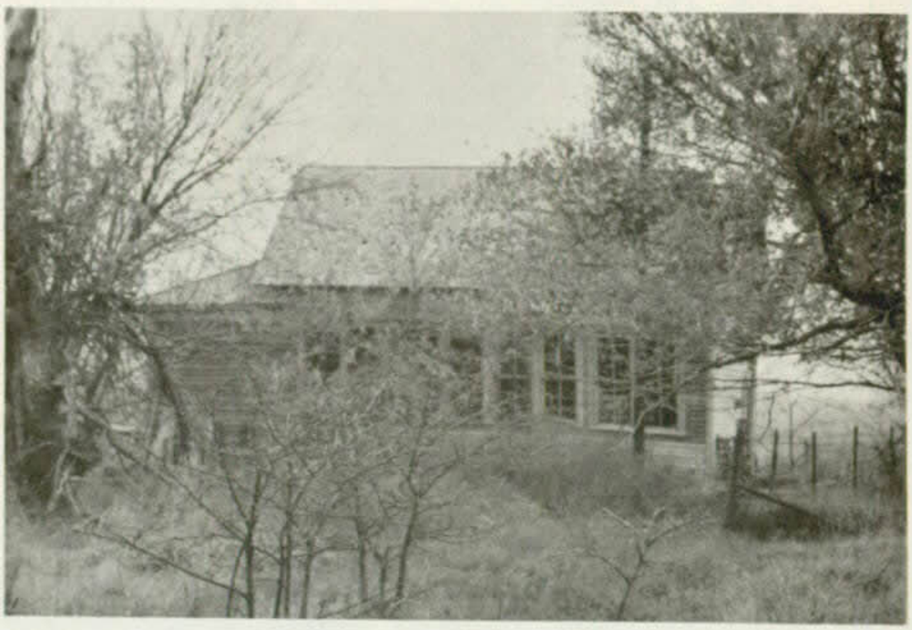
At Matfield Green, a settler opened the post office in 1870. Citizens in this community hoped that the Santa Fe Railroad would build to the area, but additional railroad construction in that district did not occur until 1923 when the Santa Fe linked Matfield Green to El Dorado to the southwest.

Regarding Matfield Green, an 1886 newspaper article reported the following local businesses: two general stores, two drug stores, a hardware concern, two hotels, a livery stable, one blacksmith shop, a school, a church, and several smaller businesses. Little of this remains today. At one time the population numbered several hundred people in Matfield Green, but it has decreased to less than 70 in the 1970s.

Regarding those portions of the Chase area in Butler and Greenwood Counties, little of pertinent historical value could be determined from a perusal of materials that dealt with these areas. There were no communities in that portion of Sycamore Township, Butler County, that pertained to the study area. The closest community in that county is Cassoday (the Prairie Chicken Capital of the World), a tiny trading center that serves local ranchers. Concerning the portion of Greenwood County included in the study area, few cultural resources exist there. Probably the most significant resource is the crossroads ghost hamlet of Lapland, once a neighborhood post office and trading center.

The Chase study area is notably void of visible historic resources. The illustrations that follow show structures representative of the few historical manmade facilities in this area.

CHASE STUDY AREA ABANDONED FARM, T22S, R9E, SECTION 20.



SCHOOLHOUSE IN CHASE STUDY AREA, T22S, R9E, SECTION 30.

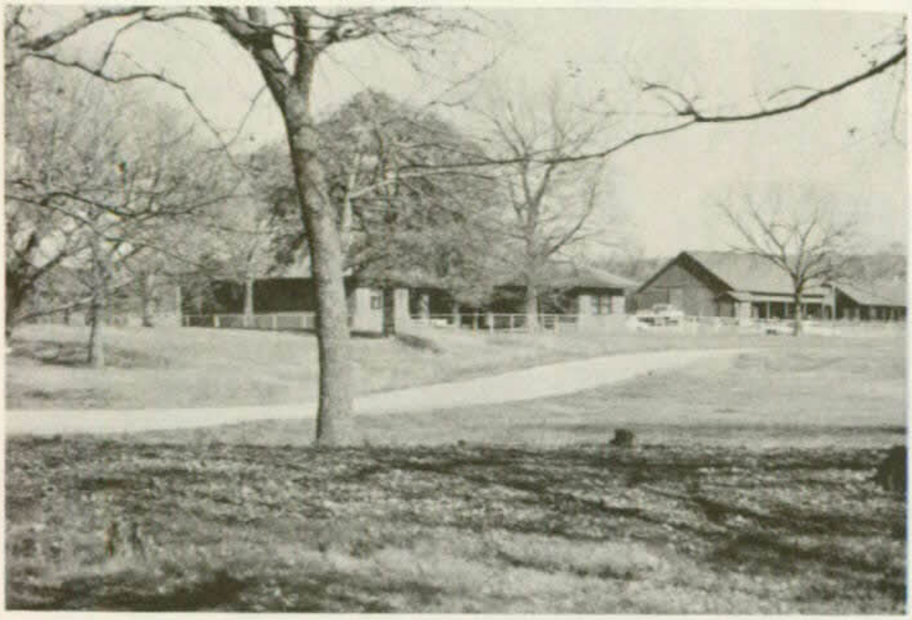
ABANDONED SCHOOLHOUSE IN CHASE AREA, T20S. R8E, SECTION 10 – Typical of a number of one-room, prairie schoolhouses in the Flint Hills.

GHOST TOWN OF LAPLAND, T20S, R9E, SECTION 2 – Located outside study area, but representative of numerous small crossroads towns now abandoned in the face of changed social and transportation situations.

OSAGE STUDY AREA

Most of this study area is located in Osage County, Oklahoma, but small portions of it extend into Cowley and Chautauqua Counties, Kansas. The Osage area of northern Oklahoma did not witness settlement until the late 19th century.

In 1872, the federal government relocated the Osage tribe on 1,477,000 acres of land carved from the old Cherokee Outlet. The Osage tribe had been assigned treaty lands in southern Kansas and had lived there since the 1820s, but the government (due to rapid settlement) deemed it imperative that the Osage move to less popular lands. Their new land in Oklahoma, according to one historian, was "rough upland meadow and hill country, most of it apparently fit only for grazing." Actually, the Indians did not fare badly. Ambitious braves demanded monetary tolls from drovers who crossed their lands on the way to Kansas railheads, and later the Osage rented portions of the bluestem prairie to cattle ranchers. Merchants in the surrounding region catered to the Indian trade. A federal Indian agency was established in 1872 at Pawhuska, the designated tribal capital. Other than intermittent contact with ranchers, merchants,



BARNARD RANCH IN THE OSAGE AREA, T27N, R8E, SECTION 30 – Large modern ranch headquarters.

MIDLAND VALLEY RAILROAD REMAINS, T28W, R7E, SECTION 36, OSAGE COUNTY – Skirts western boundary of the study area.

missionaries, and federal Indian agents, little settlement occurred on or near the Osage Reservation until the 1890s. When Oklahoma became a state in 1907, the Osage Reservation became Osage County.

In the area between Pawhuska and the Kansas border, ranching became the primary occupation. Cattle were driven northward to be shipped from Elgin, Kansas. Nearby Cedar Vale, Kansas, became a regional shopping center. Small farms developed in the creek bottomlands. However, the economic picture altered drastically in 1896 when drillers hit oil. A decade later, the growing oil industry was producing 5 million barrels annually in Osage County. Although the Indians were encouraged to sell their lands, Congress had stipulated that the Osage would retain all mineral rights on the reservation. When huge strikes were made around 1920, the Osage tribe grew wealthy. Osage County boomed. Towns sprang up overnight, then disappeared as quickly. Although the area was struck by a crime wave of epidemic proportions when the "big" money appeared in the 1920s, more efficient law enforcement ended the threat by the 1930s.

Pawhuska and other Osage County communities benefited from the new oil wealth. But smaller neighboring communities such as Foraker, Cedar Vale, and Elgin did not fare so well.

Little settlement occurred in the Chautauqua and Cowley County portions of the study area before the federal government relocated the Osage tribe in the early 1870s. Cowley was founded in 1870, Chautauqua 5 years later. The population of Chautauqua rose to 7,000 by 1875 and 11,400 by 1910. In 1970, it had declined to 5,100. On the other hand, the Cowley County population has continued to increase over the years – from 21,500 in 1879 to well over 34,000 in 1970. The present community of Elgin, Kansas, on the northern edge of the Osage study area, was founded in 1869 and grew rapidly because of its importance as a shipping point. With the influx of Oklahoma and Texas cattle in the 1870s and 1880s, Elgin acquired a cattletown reputation. Cedar Vale, also north of the study area, was founded by settlers from New England in 1870. It became a trading center that served the Osage Indian Reservation. As other Flint Hills communities, Elgin and Cedar Vale have lost population and influence in the 20th century.

ELGIN, KANSAS – A few miles northeast of the Osage area. Former cattle town – little activity presently. Note brick paving. Historically, a district that might qualify for National Register status.

ELGIN'S MAIN COMMERCIAL BLOCK – Second building from left houses a local museum.

ELGIN BAPTIST CHURCH.

ELGIN METHODIST CHURCH, 1892 – Rebuilt 1921. Unique architectural style for small town church.

LIVERY STABLE, ELGIN.

ELGIN STONE CHURCH – Currently used for hay storage.

SUMMARY

The three alternative study areas contain diverse and numerous cultural resources, most of which appear to be of regional or local significance.

Compared to the other two sites, Wabaunsee features more well-preserved, late 19th-century limestone structures including houses, churches, schools, outbuildings, bridges, and fences. Most of these handcrafted structures are situated outside, but adjacent to, the study area and along Mill Creek, along K-99 south of Alma, and in Alma itself. This community has a number of residential and commercial structures of probable National Register caliber. Fewer numbers of significant structures exist within or near the other two areas, or within nearby communities.

The most notable community of foreign-born settlers developed in the 1860s and 1870s near the present-day Wabaunsee study area. The Germanic influence produced a strong, lasting image in the Alma/Mill Creek Valley district. Chase and Osage were largely settled by native-born Americans.

Although the cattle business greatly influenced all three sites, the largest remaining ranches are located either within or near the Chase and Osage study areas. In the Wabaunsee area, there is more cropland. Historically, finished cattle were shipped from several places – Alma, Volland, Alta Vista, Strong City, Bazaar, and later Matfield Green – but Elgin, Kansas, most closely approximates the highly publicized cattletowns of the "Old West." Here numerous opportunities exist to interpret the cattle industry and its impact on a community's economic and social development. The industry influenced other Flint Hills communities as well; for instance, Cottonwood Falls and Strong City, due to their proximity to rail connections, profited from this industry.

Early farming was considered the primary economic base throughout the Flint Hills but slowly gave way to cattle grazing. Even today most croplands, such as those along Mill Creek and Caney River, grow crops to support the livestock industry. Historical research should consider the true relationship between rancher and farmer, as compared to the popular concept of constant friction between cowboy and sodbuster.

While the petroleum industry touched each site, it had the most dramatic effects in Osage County. There oil initially encouraged the immigration of whites, while in the other areas the petroleum boom followed settlement. Curiously, while about an equal number of wells are located in the Chase and Osage areas and only a few wells in the Wabaunsee area, the latter area is the largest producer of the three.

The railroad's arrival in the early 1880s encouraged rapid shipment of fattened cattle to eastern markets. Communities thrived or vanished depending on whether the

railroads reached them. For example, Strong City, although close to the county seat at Cottonwood Falls, developed as a separate economic entity due to the Santa Fe Railroad. Alma and Elgin certainly benefited from the railroads. And today both the Wabaunsee and Osage study areas have abandoned railroad rights-of-ways near them.

Undoubtedly archaeological surveys will find significant prehistoric remains. Probable habitation may reach back some 10,000 years. Local amateurs have supplied many uncatalogued artifact collections to local museums in the Flint Hills.

In historic times, the old Pottawatomie Indian Reservation included a large portion of Wabaunsee County. The Kaws resided near Council Grove, and several of their structures remain extant. During the 19th century, the federal government established reservations for the Osage on both sides of the Kansas/Oklahoma border. The Osage study area is, in large part, within the Osage Reservation; and today many tribal members live near Pawhuska.

Thus the three study areas contain salient cultural resources of varying quality and significance that make each somewhat different from the others. For example, extant historic resources partially negate total prairie integrity in the natural historical context at Wabaunsee, yet the same "intrusions" tend to display the cultural development of the prairie. Although this proposed park is viewed principally as a natural area, extant cultural resources will play a strong supportive role in the final selection process and future management. Some manmade intrusions do not necessarily destroy a site's integrity but may detract from the prairie theme. From a cultural point of view, this future park should dramatically express the vastness and isolation of the tallgrass prairie – an area and expression so important to the story of western development.

Thus, the "ideal" area should illustrate the ongoing – often harsh – relationship between man and the prairie. The Osage study area, at least in historic times, best exemplifies this crucial aspect. From the 19th century onward, the Osage and other tribes have inhabited this area. Later, white settlers' abortive farming efforts gave way to large cattle ranches. Communities such as Hewins and Elgin (near the site) illustrate the cattle industry's commercial aspects. And for the past 75 years, the oil industry has had a sizeable impact. Thus the rich interplay between man and prairie in the Osage study area would provide a solid basis for interpreting the cultural role of the prairie in American social development.

BIBLIOGRAPHY

ANDERSON, LORENE, AND ALAN W. FARLEY, COMP.
1955 *A Bibliography of Town and County Histories of Kansas.* Reprinted from *The Kansas Historical Quarterly.*

ANDREAS, A.T.
1883 *History of the State of Kansas.* Chicago.

AUGUSTA GAZETTE
1941 April 21 issue. Augusta, Kansas.

BLACKMAR, FRANK W.
1912 *Kansas: A Cyclopedia of State History, Embracing Events, Institutions, Industries, Counties, Cities, Towns, Prominent Persons, Etc.* Chicago: Standard Publishing Company.

BRIGHT, JOHN D., ED.
1956 *Kansas: The First Century.* New York: Lewis Historical Publishing.

BROWN, MYRA LOCKWOOD
1965 "Kansas' Ancient Flint Hills." *Dodge News Magazine.*

BURCHARDT, BILL
1963 "Osage Oil." *The Chronicles of Oklahoma,* vol. XLI.

BURWELL, KATE PEARSON
n.d. "The Richest People in the World." *Sturm's Statehood Magazine,* vol. II.

CARMAN, J. NEALE
1962 *Foreign Language Units of Kansas I: Historical Atlas and Statistics.* Lawrence: Kansas University Press.

CASEMENT, DAN D.
1955 *Random Recollections: The Life and Times – and Something of the Personal Philosophy – of a 20th Century Cowman.* Kansas City: Walker Publications.

CHANDLER, ALLISON
1958 "The Horse-car Interurban from Cottonwood Falls to Strong City." *The Kansas Historical Quarterly,* vol. XXIV.

CHASE COUNTY HISTORICAL SOCIETY
1940 *Chase County Historical Sketches,* vol. I.

1948 *Chase County Historical Sketches,* vol. II.

COFFEYVILLE JOURNAL
1954 August 22 issue.

1964 April 29 issue.

COOK, MARGIE
1974 "The Tallgrass Prairie Dilemma." *Kansas Alumni,* vol. LXXII.

FINNEY, FRANK F.
1962 "Progress in the Civilization of the Osage and Their Government." *The Chronicles of Oklahoma,* vol. XL.

GIBSON, ARRELL M.
1965 *Oklahoma: A History of Five Centuries.* Norman: Harlow Publishing Corporation.

HASTINGS HOUSE PUBLISHERS
1949 *Kansas: A Guide to the Sunflower State.* New York, 2nd ed.

HORN, PAUL
1950 "The Flint Hills." *The American Hereford Journal,* vol. XLI, May 15 issue.

HORRIGAN, KEVIN
1974 "Rancher Wants His Roots in Flint Hills, Not a Park." *The Kansas City Star,* October 15 issue.

HOWES, CHARLES
1972 "Historic Hotels." *Kansas,* 3rd issue.

1952 *This Place Called Kansas.* Norman: University of Oklahoma Press.

1949 "This Month in Kansas History." *The Kansas Teacher,* vol. LVII.

HOWES, CHARLES

1946 "Proposes a Park to Show the Beauty of Bluestem Region," *The Kansas City Star,* January 6 issue.

KANSAS DIRECTORY COMPANY

1907 *Business Directory and History of Wabaunsee County.* Topeka.

KANSAS HISTORICAL SOCIETY

n.d. *Historical Markers in Kansas.* Topeka: Kansas State Printing Plant.

KOLLMORGEN, WALTER M., AND DAVID S. SIMONETT

1965 *Grazing Operations in the Flint Hills – Bluestem Pastures of Chase County Kansas.* Lawrence: University of Kansas Press.

MALINE, JAMES C.

1942 "An Introduction to the History of the Bluestem-Pasture Region of Kansas." *The Kansas Historical Quarterly,* vol. XI.

MCCORMALLY, JOHN

1949 "Bluestem." *Kansas Magazine.*

MCREYNOLDS, EDWIN C.

1964 *Oklahoma: A History of the Sooner State.* Norman: University of Oklahoma Press.

MILL CREEK NEWS

1974

MOONEY, VOL P.

1916 *History of Butler County, Kansas.* Lawrence: Standard Publishing Company.

OKLAHOMA STATE HISTORICAL SOCIETY

n.d. "Osage County History." WPA, Osage County File.

RESER, JEAN S.

1955 "History of Greenwood County, Kansas." *The (Eureka) Herald,* September 22 and September 29 issues.

RICHMOND, ROBERT W.

1974 *Kansas: A Land of Contrasts.* St. Charles: Forum Press.

RUTH, KENT, COMP.
1958 *Oklahoma: A Guide to the Sooner State.* Norman: University of Oklahoma Press.

STEVENS, MAUDE R.
n.d. "Historical Greenwood County," Greenwood County File, Kansas Historical Society, Topeka, Kansas.

STRATFORD, JESSE PERRY
1934 *Butler County's Eighty Years: 1855-1935.*

THE OKLAHOMAN ANNUAL ALMANAC AND INDUSTRIAL RECORD – 1908
1908 January 28 issue.

TUTTLE, CHARLES R.
1876 *A New Centennial History of the State of Kansas.* Madison and Lawrence: Inter-State Book Company.

UNKNOWN
1872-
1972 *Chase County Centennial.*

1954 "Osage County Cattlemen Meet." *The Cattleman,* vol. XLI.

1964 "Skyline Drive." *Kansas,* 2nd issue.

WICHITA EAGLE AND WICHITA BEACON
1968 "The Flint Hills: Kansas' Commitment to the Past."

WICHITA MAGAZINE
1944 "Flint Hills Herds Convert Bluestem into 87,500,000 Pounds of Choice Steaks." Volume XXI, November 16 issue.

WINFIELD TELEGRAM PRINT
1888 "The Life and Travels of Josiah Moose." Winfield, Kansas.

ZORNOW, WILLIAM FRANK
1957 *Kansas: A History of the Jayhawk State.* Norman: University of Oklahoma Press.

LOCAL MUSEUMS

Butler County Historical Museum, El Dorado, Kansas

Cedar Vale Historical Museum, Cedar Vale, Kansas

Cowboy Hall of Fame, Oklahoma City, Oklahoma

Elgin Historical Museum, Elgin, Kansas

Hewins Museum, Hewins, Kansas

Mill Creek Museum, Alma, Kansas

Old Kaw Mission Museum, Council Grove, Kansas

Osage County Historical Museum, Pawhuska, Oklahoma

Ronniger Memorial Museum, Cottonwood Falls, Kansas

Wabaunsee County Historical Museum, Alma, Kansas

EXCERPTS FROM THE NATIONAL REGISTER OF HISTORIC PLACES FLINT HILLS COUNTIES

BUTLER COUNTY
Augusta
JAMES, C. N., CABIN
305 State Street
1868

Chester N. James, a merchant, built this cabin as a store and home on land that later became the townsite of Augusta. The 2-story rectangular building is built of logs, roughly squared and interlocked at the corners. The steep gabled roof is covered with wooden shingles. There is a simple soffit and plain cornice beneath the roof. *Private*

CHASE COUNTY
Cottonwood Falls
CHASE COUNTY COURTHOUSE
On the square at the south end of Broadway
1873, John G. Haskell

The Chase County Courthouse is a three-story, tooled limestone building with a high mansard roof surmounted by a clock tower. A belt course separates the first and second floors. The cornice is bracketed and the roof is ornamented by iron cresting. Windows on the first and second levels are paired beneath arched lintels. Inside, a spiral stairway connects all floors. This is the oldest courthouse in Kansas still being used.
County

CHASE COUNTY
Strong City vicinity
SPRING HILL FARM AND STOCK RANCH HOUSE
3 miles north of Strong City on Kans. 177
1881

The Spring Hill Ranch House is a large stone dwelling built against a hillside with three stories on the front and two on the rear. It has a mansard roof and is built of native limestone cut to uniform size and laid in regular horizontal courses. All corners are quoined with projecting stone blocks. A large porch with classic columns extends along the lower floor of the three-story facade. There is a rubble stone barn with smoothed blocks at the corners and a modified gable roof. Other outbuildings are squared stone block construction with hip roofs. The house and outbuildings together form a unified complex in appearance and function.
Private; not accessible to the public

CHASE COUNTY
Cottonwood Falls vicinity
WOOD HOUSE
0.5 mile E of Cottonwood Falls
1860's

Samuel Newitt Wood (1825–1891), one of Kansas' most flamboyant 19th-century politicians, came to the state in 1854 to support the free state cause. He helped establish Chase County and published the county's first newspaper in 1859. The same year he was elected to the territorial legislature and later served in the first state senate. Wood was murdered in southwest Kansas as a result of his involvement in the county seat war of Stevens County. He is buried in Cottonwood Falls. The Wood House is a large, 2-story limestone dwelling. *Private; not accessible to the public*

COWLEY COUNTY
Winfield
HACKNEY, W. P., HOUSE
417 E. Tenth Street
1886

This is a 3-story vernacular structure with walls of native limestone decreasing in thickness from the first to the top floors. The entrance protrudes several feet from the face of the structure and extends above the roofline terminating in a stone gable. The steeply pitched hipped roof is covered with wood shingles and has a profusion of dormers. The house was built for William P. Hackney who was a member of the state legislature as both a representative and senator and was elected mayor of Winfield in 1887. He was instrumental in the construction of more than a dozen buildings in the town, including an important business block.
Private

COWLEY COUNTY
Winfield vicinity
MAGNOLIA RANCH (CHESBRO RANCH)
10 miles SE of Winfield on U.S. 77
1883

The Magnolia Ranch house is a 2 1/2-story early Renaissance style structure with full basement. Exterior walls are stone in a random ashlar pattern and the house is covered by a standing seam hipped metal roof with an overhang supported by widely spaced pairs of brackets. Two large observation towers are at the center of the roof. The ranch house and outbuildings make up one of the few remaining rural complexes of historic stone buildings in Kansas which continue to serve their original purpose. *Private*

MORRIS COUNTY
Council Grove
COUNCIL GROVE HISTORIC DISTRICT
1858

Because of its water, abundant grass, and timber, Council Grove was an important way-point on the Santa Fe Trail. The town, which was incorporated in 1858, was named on the occasion of a treaty negotiation with the Osage Indians in 1825. Later, other councils were held here as caravans organized themselves to cross the area inhabited by hostile Indians. Within the town a number of landmarks survive: the Last Chance Store (1857); the Old Kaw Mission (1850–1851); the Post Office Oak; the Hays Tavern; and the Council Oak Site.
Multiple public/private
NHL; HABS

MORRIS COUNTY
Council Grove
FARMERS AND DROVERS BANK
201 W. Main Street
1892

The Farmers and Drovers Bank is a brick structure with hand-hewn stone trim. First-floor windows are topped by semicircular arches containing stained glass, and the rectangular second-floor windows also have stained glass panels. Protruding limestone towers divide the upper windows into pairs. These towers terminate in turrets at the roof. The Farmers and Drovers Bank was organized on January 26, 1882.
Private

MORRIS COUNTY
Council Grove
LAST CHANCE STORE
500 W. Main Street
1857

The Last Chance Store, built by Tom Hill, is one of the two oldest commercial structures in Council Grove. Located on the north side of the Santa Fe Trail, the store presented traders with their final opportunity to purchase supplies between Council Grove and Santa Fe, New Mexico. The rectangular, one-story, one-room building has walls of hand-hewn limestone. Windows and doorways are simple rectangular openings with rough stone sills and flat, smoothed stone lintels. A post office was once housed in the store, which also served as a government trading house.
Private

MORRIS COUNTY
Council Grove
OLD KAW MISSION
500 N. Mission Street
1851

An 1846 treaty with the Kansas or Kaw Indians relegated them to a 20–mile-square reservation including the site of present-day Council Grove. In 1850 the Methodist Episcopal Church, South, signed a government contract thereby agreeing to establish a mission and school for the Kaw Indians at Council Grove. The mission building is a two-story, rectangular, stone structure with a gable roof and end chimneys. It could house 50 students plus teachers and mission workers. High costs of operation and poor attendance resulted in the withdrawal of government money, so the school was forced to close in 1854. The mission is within the Council Grove Historic District, a National Historic Landmark.
State

MORRIS COUNTY
Council Grove vicinity
WILLIAM YOUNG ARCHEOLOGICAL SITE
4.5 miles north of Council Grove off Kans. 177
Pre-Columbian

Artifacts found at this location represent a heretofore unrecognized prehistoric culture. Termed the Munkers Creek Phase, the cultural group falls within the Archaic Period, and radiocarbon tests indicate habitation dates were 3,000 to 5,000 years ago. The site is a buried camp situated four to seven feet below ground. Artifacts found include projectile points, knives, and celts of distinctive types.
Federal

POTTAWATOMIE COUNTY
St. Mary's vicinity
POTTAWATOMIE INDIAN PAY STATION
E of the city limits on Mission Street, near St. Mary's College campus
c. 1850's

The Indian pay station was used by government agents for paying the Pottawatomie Indians their annuities. The Indians had moved from their tribal lands in the Great Lakes region in the 1830's to a government reservation in Kansas. As part of the land exchange the federal government agreed to pay the Indians a $3,000,000 allotment in trimonthly installments to individuals. The pay station is the oldest building of the St. Mary's Indian Mission as well as the oldest in the county. It is a 1-story stone structure with a later frame addition. *Private*

POTTAWATOMIE COUNTY
Wamego
OLD DUTCH MILL (SCHONHOFF MILL)
Wamego City Park
1879

This is a circular structure about 20 feet in diameter at the base and about 40 feet high with walls of native limestone in a random ashlar pattern. The stones are irregularly coursed and rough-hewn. The roof is a truncated conical form with a penthouse-like structure on top. The mill was built by a Dutch immigrant John B. Schonoff. *Municipal*

WABAUNSEE COUNTY
Wabaunsee
BEECHER BIBLE AND RIFLE CHURCH
Southeast corner of Chapel and Elm Streets
1862

After passage of the Kansas-Nebraska Act (1854), allowing the residents of a territory to decide whether it was to be slave or free, interest in the settlement of Kansas grew. A group of antislavery men met in New Haven, Connecticut, in the spring of 1856 with the intent of settling in Kansas. The Reverend Henry Ward Beecher addressed their final meeting and suggested that Sharps carbines would be of more use to the colony than Bibles. Beecher's congregation in Brooklyn, New York, supplied money for some of the rifles. About 70 colonists arrived in Kansas in April, 1856, and founded the town of Wabaunsee. Their church, completed in 1862, is built of native limestone with cut stone quoins and window and door sills and jambs. It is surmounted by a wooden belfry; the wooden entry is a later addition. The structure is one of the earliest churches in Kansas.
Private
HABS

RECENT ADDITIONS TO THE NATIONAL REGISTER

OKLAHOMA

Kaw County, Nez Perce Reservation, east of Tonkawa

Osage County, Osage Agency, Pawhuska

Pawnee County, Pawnee Indian Agency, Pawnee

KANSAS

Lower Fox Creek School, Chase County, northwest of Strong City on Kansas 13/57

Old Arkansas City High School, Cowley County, 300 West Central, Arkansas City

Main Post Area, Fort Riley, Geary County, northeast of Junction City on Kansas 18

Christian Wetzel Cabin, Geary County, 2 miles east of Junction City at junction of I-70 and Kansas 57

Curry Archaeological Site, Greenwood County, northwest of Madison

Vermillion Creek Crossing, Oregon Trail, Pottawatomie County, northwest of Belvue

Vermillion Creek Archaeological District, Pottawatomie County, Onaga vicinity, Vermillion River and drainage pattern from Onaga south to its confluence with the Kansas River

I: VISUAL/SCENIC RESOURCES

VISUAL/SCENIC RESOURCES

ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by

Denver Service Center
National Park Service
United States Department of the Interior
and
Department of Landscape Architecture
Kansas State University

CONTENTS

TABLES

GRAPHICS

---

*These maps, prepared at 1:24,000 scale, are not reproducible without unacceptable loss of information. All these maps can be reviewed at the National Park Service's Denver Service Center. Some can be reproduced full scale on request and at the expense of the requestor.

INTRODUCTION

The tallgrass prairie is characterized by the predominance of grasses, scarcity of shrubs, absence of trees (except along rivers and streams), and the presence of other drought-enduring flora. Physically it encompasses level areas, knolls, steep bluffs, rolling-to-hilly terrain, valleys, and extensive alluvial floodplains. Wildlife of great variety and number also characterize the true prairie. The visual expression of the prairie is best described in terms of the horizontal vastness and expansiveness of the uplands and the intimacy and enclosure of the riparian lowlands. This is a landscape of locally high diversity in the context of an immense regional continuum.

Three of the six National Park Service criteria for prairie parklands relate to scenic resources and scenic quality (see appendix A). These specific criteria (3, 5, and 6) require that a study area be:

> An area that manifests the scenic attributes of the prairie – spaciousness, expansive grasslands, riparian woodlands, and rolling topography.
>
> A site that can be adapted to provide numerous and diverse opportunities for visitor enjoyment of natural, cultural, and scenic values within a natural tallgrass-prairie setting.
>
> A land area that is relatively free of adverse manmade intrusions or disturbances.

ANALYSIS OF VISUAL UNITS

Criteria 3 and 5 relate to the visual representativeness of the prairie landscape. Three distinct visual landforms that typify the prairie landscape have been identified within the study areas: broad upland, transitional or rolling upland, and lowland.

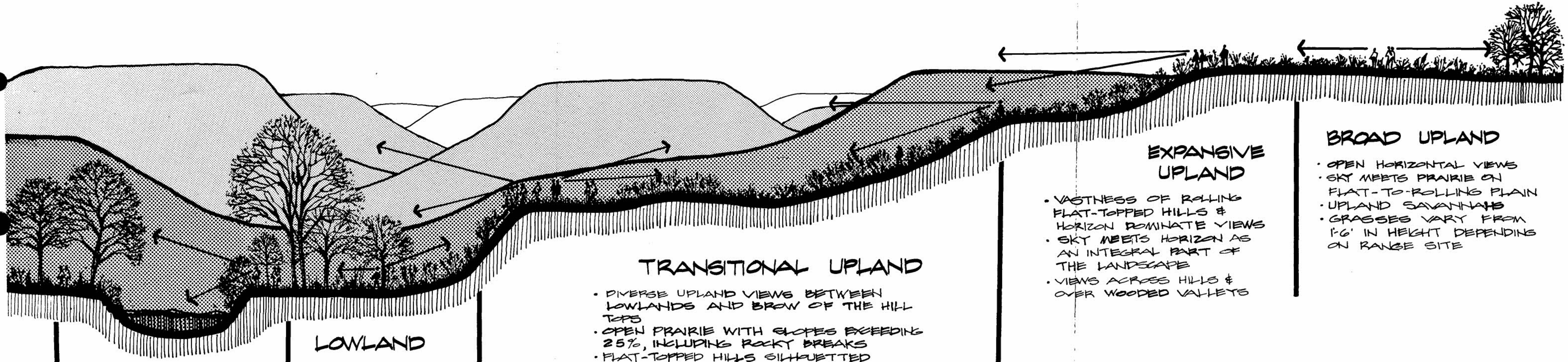
Broad upland prairie provides distinct visual experiences within the landscape. Most fundamental is the relationship of the sky to the horizon. In broad upland areas there are open horizontal views where the sky meets the prairie on a flat-to-rolling plain. There are occasional upland savannahs where native grasses vary in height from 1 foot to over 6 feet, depending on the range site.

Transitional or rolling upland prairie provides diverse upland views between lowlands and broad uplands. Flat-topped hills are silhouetted against the skyline in all directions. The most expansive upland views are found at the brow of the hill between the broad upland and transitional upland areas. Here the vastness of rolling, flat-topped hills and the horizon line dominate the views. The sky meets the horizon as an integral part of the landscape. The views are across hills and over wooded valleys.

Lowland prairie areas are enclosed by valley walls. The sky is subordinate to topography and local vegetation zones, where grasses may reach heights up to 8 feet. Riparian zones within the lowland areas provide a secluded prairie microenvironment dominated by wooded growth, running water, and seasonal waterfowl.

The sectional diagram, Typical Prairie Views in the Flint Hills, illustrates the three major visual units and their subunits. These visual units are also illustrated by the visual features aerial perspective drawings (PRAI 40,042, 40,043, and 40,044). Study area maps entitled Visual Features, Natural Scenic Resources (PRAI 40,039, 40,040, and 40,041) delineate the spatial distribution of upland, transitional, and lowland prairie, as well as woodlands, drainages, and ridgelines.

The relationship between the visual aspects of these natural landscape features and existing and planned land uses is the crux of parkland criteria number 6. Manmade elements of the landscape vary in their degree of intrusiveness or disturbance. Similarly, the degree of visual sensitivity of the visual units to intrusions varies in terms of the units' capacity to "absorb" these intrusions.



RIPARIAN

- SECLUDED PRAIRIE MICRO-ENVIRONMENT - DETAILED INWARD VIEWS - SHADE
- OAK-HICKORY ASSOCIATION
- ROCK OUTCROPPING
- CLEAR RUNNING WATER
- RIFFLES & BROKEN WATER
- LARGE WATER FOWL

LOWLAND

- ENCLOSED VIEWS BY VALLEY WALLS
- 0-3% SLOPES
- TALL GRASSES - 6'-10'
- SHRUBS & TREES
- SKY IS SUBORDINATE TO TOPOGRAPHY & VEGETATION

TRANSITIONAL UPLAND

- DIVERSE UPLAND VIEWS BETWEEN LOWLANDS AND BROW OF THE HILL TOPS
- OPEN PRAIRIE WITH SLOPES EXCEEDING 25%, INCLUDING ROCKY BREAKS
- FLAT-TOPPED HILLS SILHOUETTED AGAINST THE SKYLINE
- VARIETY OF GRASSES VARYING IN HEIGHT FROM 1'-6' DEPENDING ON RANGE SITE

EXPANSIVE UPLAND

- VASTNESS OF ROLLING FLAT-TOPPED HILLS & HORIZON DOMINATE VIEWS
- SKY MEETS HORIZON AS AN INTEGRAL PART OF THE LANDSCAPE
- VIEWS ACROSS HILLS & OVER WOODED VALLEYS

BROAD UPLAND

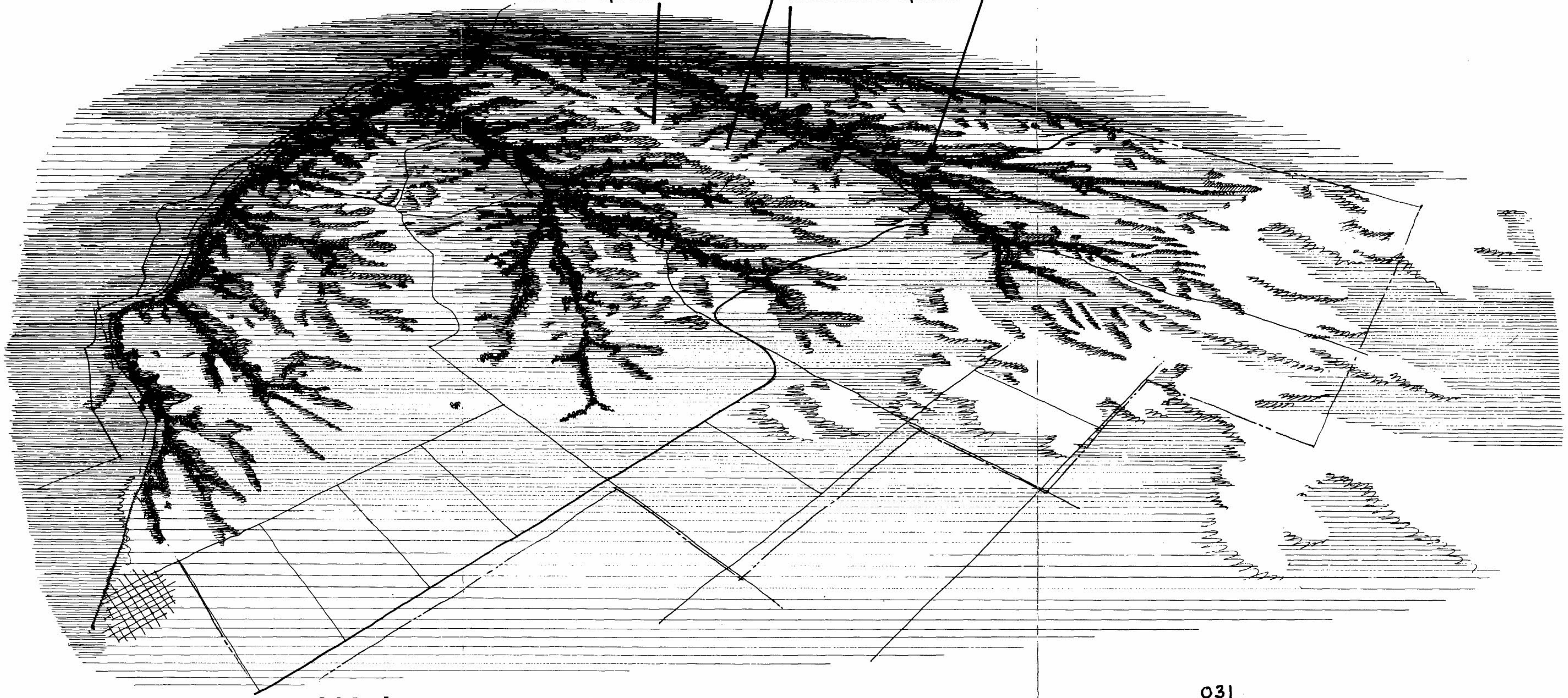
- OPEN HORIZONTAL VIEWS
- SKY MEETS PRAIRIE ON FLAT-TO-ROLLING PLAIN
- UPLAND SAVANNAHS
- GRASSES VARY FROM 1'-6' IN HEIGHT DEPENDING ON RANGE SITE

Typical Prairie Views In The Flint Hills

Range Sites and Related Soil Series

Prairie National Park Study

United States Department of the Interior / National Park Service



Wabaunsee - typical views

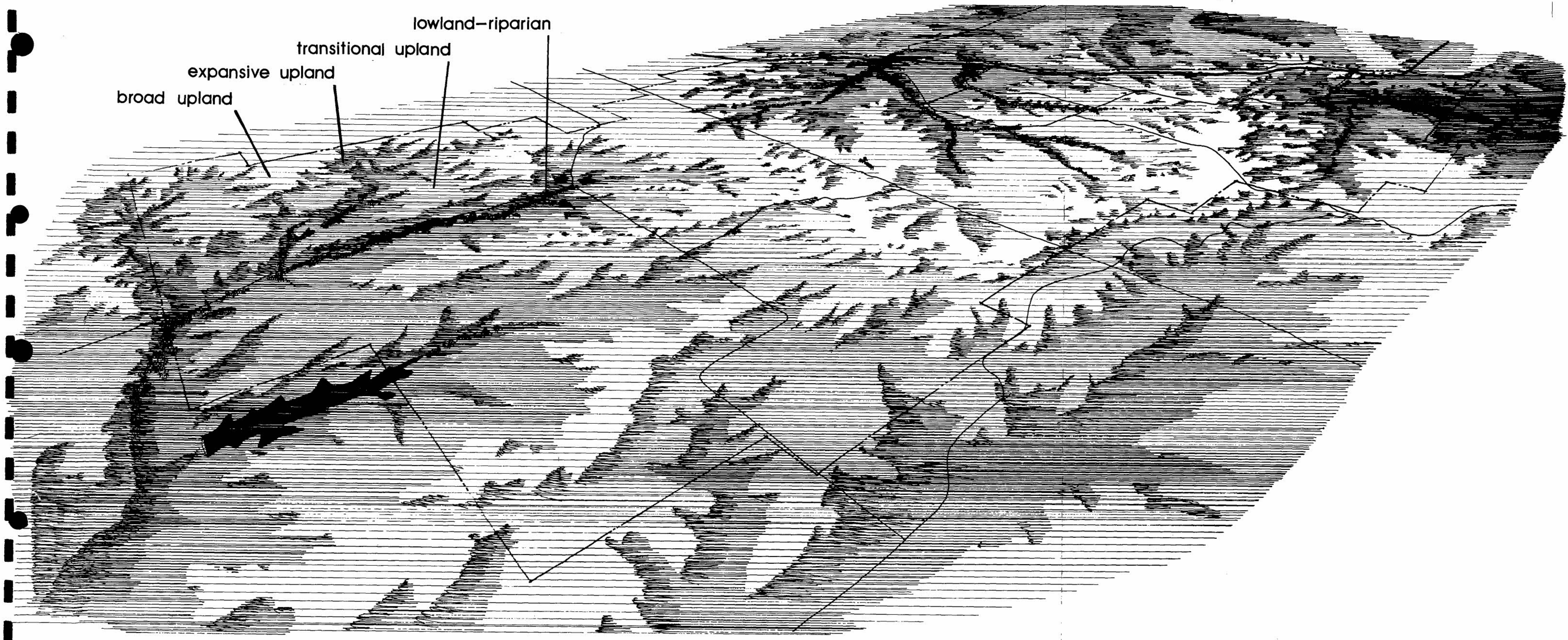
031
40042
DSC MAY 75

4

ON MICROFILM

Prairie National Park Study
United States Department of the Interior / National Park Service

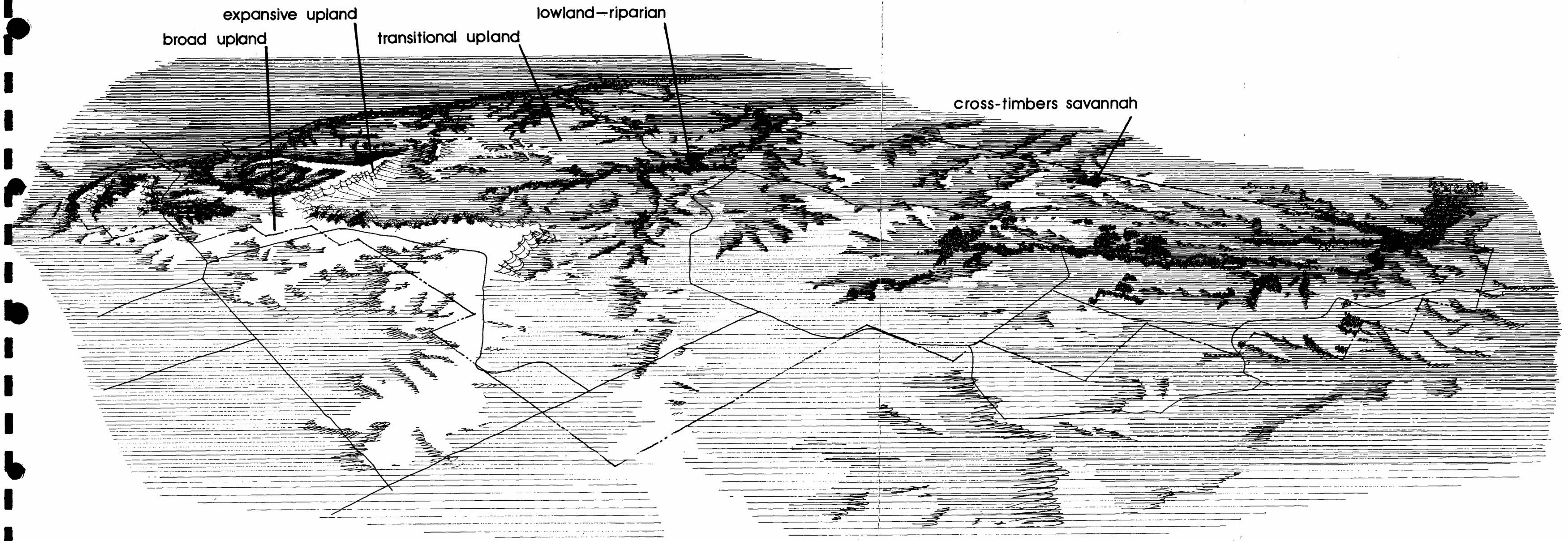
VISUAL FEATURES (WABAUNSEE) *



Chase - typical views

031
[redacted] 40043
DSC | MAY 75
ON MICROFILM

VISUAL FEATURES (CHASE) *



Osage - typical views

Prairie National Park Study

United States Department of the Interior / National Park Service

031
[redacted] | 40044
DSC | MAY 75
ON MICROFILM

WABAUNSEE – SLOPES*

WABAUNSEE – ASPECT AND DRAINAGE*

CHASE – RELIEF*

CHASE – SLOPES*

CHASE – ASPECT AND DRAINAGE*

OSAGE – RELIEF*

OSAGE – SLOPES*

OSAGE – ASPECT AND DRAINAGE*

The Flint Hills Ridge separates watersheds that drain to the north and south, reaching low points of under 1,300 feet at northern and southern ends of the study area. Another ridge, exceeding 1,600 feet, separates the Verdigris River from Little Cedar Creek. There is an elevation difference of 350 to 400 feet within the area.

The headwaters of Otis Creek, Olsen Creek, and the west branch of Fall River drain to the south into the east and west branches of the Fall River outside the area. The headwaters of Little Cedar Creek, Thurman Creek, and the south fork of the Cottonwood River drain to the north – all but Thurman Creek terminating outside the area. The headwaters of the Verdigris River are contained within an oil field just outside the study area. The Verdigris drains to the north through the area, then turns east to exit.

The Chase area is characterized physiographically by broad upland ridges, gentle (3 to 10 percent) to moderate (10 to 25 percent) slopes, and broad flat (0 to 3 percent slopes) alluvial valleys. Slopes over 25 percent are localized along valley walls, dispersed throughout the area. This study area is typified by expansiveness of terrain, rather than by physiographic diversity (see the Chase Relief map, PRAI 40,018, Slope map, PRAI 40,021, and Aspect and Drainage map, PRAI 40,027).

OSAGE STUDY AREA

The greatest portion of the Osage area consists of rolling topography, which contrasts with the flat upland topography to the west. The rolling areas are comprised of Pennsylvanian limestones and shales, the flat uplands of Permian age rocks. Where these two formations contact, a steep scarp separates them.

The highest elevations range from 1,300 to 1,360 feet along the western upland portion of the study area. All of the major watersheds in the area drain east or north into the Caney River. The lowest elevations are under 900 feet along the east and northern edges. There is a 450- to 500-foot difference in elevation within the Osage study area.

East-west trending ridges separate the watersheds draining out of the area. These watersheds include Acker, Smith, Buck, Dog, Pond, and Sand Creeks. Rock Creek and Caney River provide the northern boundary.

Steep slopes (over 25 percent) occur along the major scarp and in some valley areas. With the exception of the Caney River, broad alluvial floodplains are not characteristic of the Osage landscape; rather, narrow V-shaped valleys cut through the Pennsylvanian limestones and shales. The dominant landforms of the Osage study area are the continuously rolling central hills and the flat uplands providing expansive views in the west (see the Osage Relief map, PRAI 40,019, Slope map, PRAI 40,022, and Aspect and Drainage map, PRAI 40,025).

D: WATER RESOURCES

VISUAL FEATURES (OSAGE) *

Broad upland and expansive upland areas have the least capacity to visually absorb intrusions. Here the land is flat-to-rolling, and views are more expansive than at any other position in the landscape. These are perhaps the most important views in the prairie landscape, and any vertical intrusion is disruptive.

Transitional uplands are less sensitive to visual intrusions than broad and expansive uplands. The inherent diversity of this visual unit provides some potential to visually absorb manmade intrusions. Transitional upland prairie predominates in the study areas.

Lowland and riparian areas have the highest capacity to visually absorb manmade intrusions. Here both the topography and vegetation enclose and screen land-use intrusions from distant views. Views in the lowland prairie landscape are generally inward and contained.

VISUAL UNITS – WABAUNSEE STUDY AREA

In the Wabaunsee study area, a wide variety of visual experiences are provided because of the diversity of topography, range sites, and drainage patterns. Upland prairie units conform to the upland ridges of the area. Transition prairie units conform to the rolling landscape between the uplands and valley bottoms where extensive lowland and riparian views are provided. (See Visual Features map, PRAI 40,039.)

VISUAL UNITS – CHASE STUDY AREA

The Chase study area does not provide the high diversity of visual experiences found in the Wabaunsee area. Upland and transitional visual units dominate much of the area, and lowland areas are sparse in woodlands. Rather than diversity, this area provides predominantly expansive views of the prairie. An exception is the west branch of the Fall River valley, where there is considerable topographic diversity. (See Visual Features, PRAI 40,040.)

VISUAL UNITS – OSAGE STUDY AREA

There are a wide range of visual experiences in the Osage area. Broad upland and expansive upland views are best represented along the western portion of the study area. There are isolated portions of upland visual units in the eastern portions of the area, while the predominant pattern is transitional views in rolling topography. Lowland and riparian views are found along the east-flowing creek valleys. The greatest abundance of running water occurs in the Osage area.

table 1

Element	Intrusion level	Osage: Total	Osage: Lowland	Osage: Transitional	Osage: Upland	Chase: Total	Chase: Lowland	Chase: Transitional	Chase: Upland	Wabaunsee: Total	Wabaunsee: Lowland	Wabaunsee: Transitional	Wabaunsee: Upland
		ELEMENT QUANTITIES				ELEMENT QUANTITIES				ELEMENT QUANTITIES			
DIRT ROAD	LOW	97.25	15.81	59.28	22.16	49.63	4.36	32.39	12.88	25.86	5.59	15.91	4.36
QUARRY	LOW	1		1						2		2	
AIRSTRIP	LOW												
GRAVEL ROAD	LOW	39.59	13.55	23.01	3.03	63.36	21.6	32.48	9.28	49.62	6.63	21.4	21.59
STONE FENCE	LOW									6		6	
RAILROAD	LOW	4.45		2.84	1.61								
CEMETERY	LOW	2		1	1	1		1					
POND	LOW MODERATE	257	19	221	17	160	13	144	3	136		117	19
DISTRIBUTION LINE	LOW MODERATE	10.13	10.13			42.61	14.77	22.73	5.11	64.52	11.74	30.68	22.1
TWO-LANE PAVED ROAD	LOW MODERATE	14.78	.20	8.14	6.44	1.8	1.8			24.53	1.33	17.9	5.3
FOUR-LANE PAVED ROAD	LOW MODERATE												
PUMP JACK	HIGH MODERATE	7		7		28		25	3	16		10	6
DUMP	HIGH MODERATE	1	1							1		1	
SUBSTATION	HIGH MODERATE					1	1			1		1	
HOUSE	HIGH MODERATE	15	7	6	2	17	9	8		34	19	9	6
TRANSMISSION LINE	HIGH MODERATE					4.83	.19	4.55	.09				
RESERVOIR	HIGH MODERATE	1		1		5	5						
RADIO TOWER	HIGH					2		2					
STORAGE TANK	HIGH									3	1	2	
FARM COMPLEX	HIGH	23	20	2	1	11	9	2		65	23	25	17
MICROWAVE TOWER	HIGH					1			1				
WATER TOWER	HIGH												
TOWN	HIGH												

physical intrusion quantities

QUANTIFICATION OF VISUAL INTRUSIONS

Land-use features are interpreted in terms of visual intrusions introduced by man into the prairie. This study does not attempt to assess the aesthetic value of land-use elements. Rather, it is concerned only with the extent of visual disturbance associated with each existing land-use feature in the three visual units already described.

The following are land uses that were quantified by points for occurrences:

- quarry
- airstrip
- cemetery
- pond
- oil well (pump jack)
- dump
- substation
- house
- reservoir
- radio tower
- oil storage tank
- farm complex
- microwave tower
- water tower
- town

Other land uses were quantified in terms of lineal miles:

- dirt road
- gravel road
- stone fence
- railroad
- distribution line
- two-lane paved road
- four-lane paved road
- transmission line

Table 1 indicates the quantities of these land-use elements for each visual unit within each study area. Table 1 clearly shows that the Osage area has the lowest level of physical intrusions, Wabaunsee the highest level, and Chase represents the mean level of physical intrusions.

MAGNITUDE OF VISUAL DISTURBANCE

The magnitude of visual disturbance of the physical intrusions inventoried in each study area was established on the basis of height, color, spatial volume, form, and density. Numerical values were assigned to each of these indicators of disturbance. When totaled, these numerical values were divided into four levels of visual disturbance: low, low to moderate, moderate to high, and high.

Disturbance Indicator	Numerical Value
Height	
Horizontal	0
0-6 feet	1
6-30 feet	2
30-60 feet	3
60-100 feet	4
100 + feet	5
Color	
Natural	1
Harmonious (earth tones)	2
Unharmonious (silver, red, white, etc.)	3
Spatial Volume or Envelope	
Void	0
Little volume (pond)	1
Moderate volume (house)	2
Large volume (reservoir)	3
Form	
Natural	0
Mostly horizontal	1
Vertical and horizontal	2
Vertical only	3
Visual Density	
Void	0
Lattice	1
Lattice/solid	2
Solid/lattice	3

The latter two indicators, form and density, were combined as indicators of mass by taking the average of the two values. The following formula illustrates how all of the disturbance values were combined:

$$\text{height} + \text{color} + \text{volume} + \frac{\text{form} + \text{density}}{2} \text{ or mass} = \text{magnitude of visual disturbance}$$

As an example, a typical prairie house is less than 30 feet high and built of materials harmonious in color with the prairie. The spatial volume or envelope is moderate in scale, its form is both horizontal and vertical, and its density is solid. When the established numerical values are applied to this land-use feature, the following numerical expression results:

	Height	Color	Volume	Form	Density	Mass $\frac{F+D}{2}$	Total Points	Normalized Value
House	2	2	2	2	4	3	9	62

Total points have been normalized to a 100-point base. The maximum number of points that can be attained from this system is 14.5, and this has been assigned a value of 100. The maximum number of disturbance points that were actually accumulated by any of the land uses was 12. As a result, local towns or communities that have been assigned 12 points have a disturbance value of 83 points out of a possible 100. Table 2 lists each land use and its magnitude of visual disturbance, both numerically and qualitatively. Four levels of visual disturbance were established based on this evaluation system: low, low to moderate, moderate to high, and high.

MAGNITUDE OF VISUAL DISTURBANCE

table 2

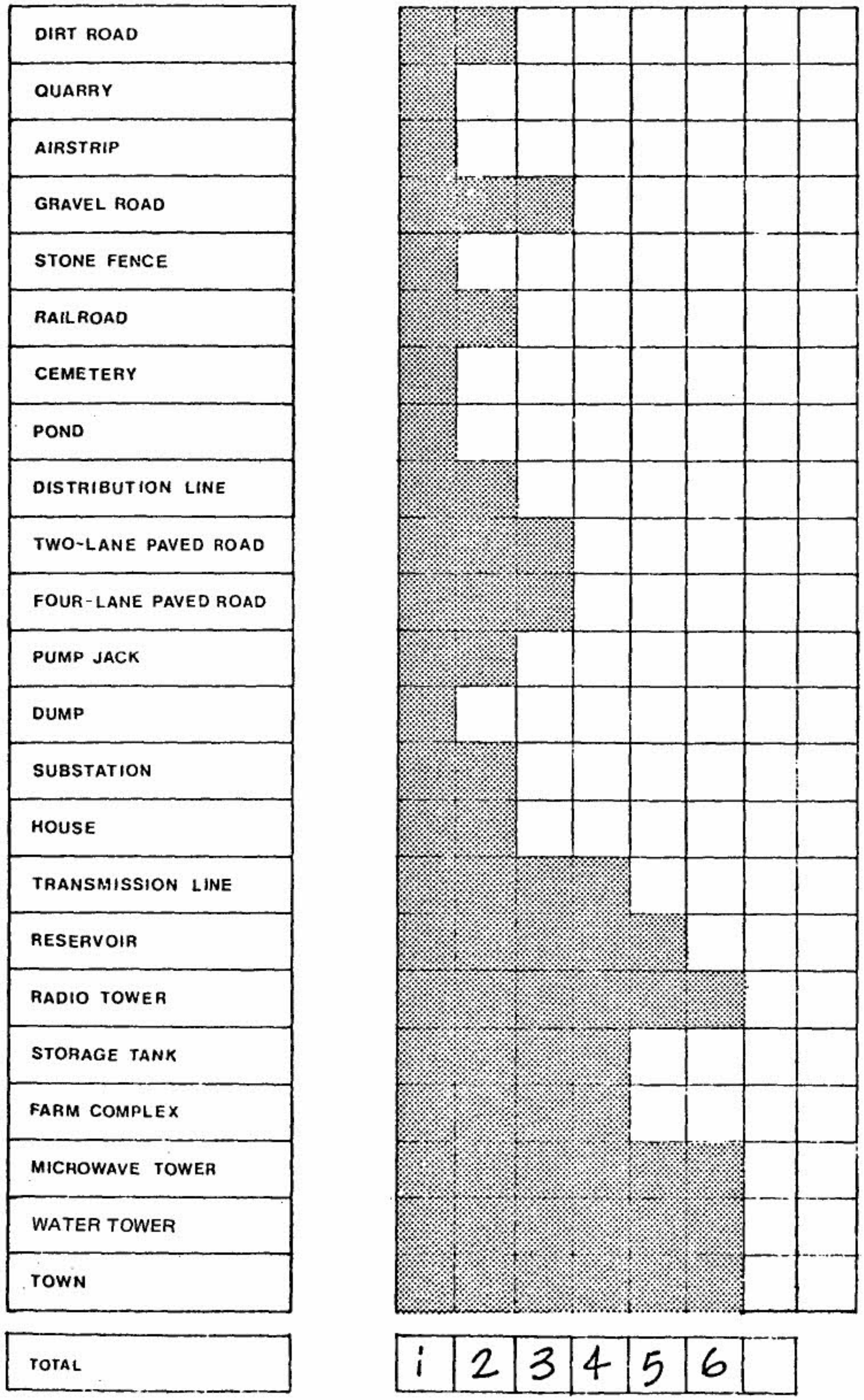
		HEIGHT	COLOR	VOLUME	FORM	DENSITY	MASS = $\frac{F+D}{2}$	TOTAL	VALUE
DIRT ROAD	LOW	0	1	1	0	1	.5	2.5	17
QUARRY		0	1	2	1	0	.5	3.5	24
AIRSTRIP		1	1	1	1	0	.5	3.5	24
GRAVEL ROAD		0	1	1	1	4	2.5	4.5	30
STONE FENCE		1	1	1	1	4	2.5	5.5	38
RAILROAD		1	2	1	2	1	1.5	5.5	38
CEMETERY		1	2	1	3	1	2	6	41
POND	LOW MODERATE	1	2	1	1	4	2.5	6.5	45
DISTRIBUTION LINE		2	2	1	2	1	1.5	6.5	45
TWO-LANE PAVED ROAD		0	2	2	2	4	3	7	48
FOUR-LANE PAVED ROAD		0	2	2	2	4	3	7	48
PUMP JACK	HIGH MODERATE	2	2	2	2	2	2	8	55
DUMP		1	3	2	2	2	2	8	55
SUBSTATION		2	2	2	2	2	2	8	55
HOUSE		2	2	2	2	4	3	9	62
TRANSMISSION LINE		3	3	2	2	1	1.5	9.5	65
RESERVOIR		2	2	3	1	4	2.5	9.5	65
RADIO TOWER	HIGH	5	3	1	3	1	2	11	76
STORAGE TANK		2	3	3	2	4	3	11	76
FARM COMPLEX		3	3	3	2	3	2.5	11.5	79
MICROWAVE TOWER		5	3	2	3	1	2	12	83
WATER TOWER		4	3	2	3	3	3	12	83
TOWN		3	3	3	2	4	3	12	83
TOTAL		5	3	3	3	4	3.5	14.5	100

VISUAL INFLUENCE ZONES

The maximum limit of visual disturbance or viewshed of each land use was evaluated to establish the extent of visual disturbance within each study area. Viewshed limits are shown on table 3. In general, those land uses with the greatest disturbance are visible for the longest distances. Six miles was considered the limit of visual influence for any of the land uses.

MAXIMUM LIMIT OF VIEW IN MILES

table 3



VISUAL DISTURBANCE ASSESSMENT

By combining information on the occurrence, visual disturbance, and visibility of land uses in each study area, it was possible to establish general levels of visual disturbance within and surrounding each study area.

The first step in this study was the delineation of viewsheds within the study areas. This resulted in plotting viewsheds based on the limits of visibility, modified by topographic and vegetative screening. In order to compare visual disturbance levels in each study area, the number of acres of each viewshed was multiplied by the number of visual disturbance points of each land use.

Two products resulted from this step. First, visual disturbance maps were produced for each study area (PRAI 40,046, 40,047, and 40,048) showing the spatial distribution of each disturbance. Secondly, the numerical values reflecting disturbance levels are shown on table 4.

Table 3 indicates that the Chase study area has the highest level of visual disturbance, both in total as well as in each visual unit. This is primarily due to the high magnitude of the intrusions and the openness of the landscape in the Chase study area. The level of visual disturbance in the Chase area is over 1½ times greater than in the Wabaunsee area and over 2½ times greater than in the Osage area.

The distribution of these visual disturbances within the three study areas is critical. High levels of visual disturbance located in the central upland portions of the study areas are the least desirable. In the Chase study area, several centrally located upland intrusions occupy important topographic positions. In the Wabaunsee area, high levels of disturbance are localized and confined to relatively small or peripheral areas in the uplands. High levels of visual disturbance are restricted to small, isolated areas in transitional or lowland visual units.

The second major step was the evaluation of the degree of visual disturbance caused by land uses outside the study areas. Viewsheds were established for land-use elements located up to 6 miles outside the study areas that could be seen within the areas. The number of acres of each viewshed was multiplied by the level of visual disturbance. (See Land Use Visual Assessment, 6-Mile Area, PRAI 40,051, 40,052, and 40,053.)

Table 5 summarizes the levels of visual disturbance both within and surrounding each study area. The Osage area has the least overall visual disturbance, while the Chase area has the most.

VISUAL DISTURBANCE (WABAUNSEE) *

VISUAL DISTURBANCE (CHASE) *

VISUAL DISTURBANCE (OSAGE) *

table 4

VISUAL DISTURBANCE — OSAGE

		Total	Lowland	Transitional	Upland
LOW	DIRT ROAD	935	152	570	213
LOW	QUARRY	2		2	
LOW	AIRSTRIP				
LOW	GRAVEL ROAD	671	230	390	51
LOW	STONE FENCE				
LOW	RAILROAD	31		20	11
LOW	CEMETERY	30		3	27
LOW MODERATE	POND	1082	113	885	84
LOW MODERATE	DISTRIBUTION LINE	288	288		
LOW MODERATE	TWO-LANE PAVED ROAD	349	5	192	152
LOW MODERATE	FOUR-LANE PAVED ROAD				
HIGH MODERATE	PUMP JACK	222		222	
HIGH MODERATE	DUMP	2	2		
HIGH MODERATE	SUBSTATION				
HIGH MODERATE	HOUSE	575	198	221	156
HIGH MODERATE	TRANSMISSION LINE				
HIGH MODERATE	RESERVOIR	57		57	
HIGH	RADIO TOWER				
HIGH	STORAGE TANK				
HIGH	FARM COMPLEX	727	340	318	69
HIGH	MICROWAVE TOWER				
HIGH	WATER TOWER				
HIGH	TOWN				
	TOTAL	4971	1328	2880	763

VISUAL DISTURBANCE — CHASE

		Total	Lowland	Transitional	Upland
LOW	DIRT ROAD	302	27	199	76
LOW	QUARRY				
LOW	AIRSTRIP				
LOW	GRAVEL ROAD	678	230	351	97
LOW	STONE FENCE				
LOW	RAILROAD				
LOW	CEMETERY	4	4		
LOW MODERATE	POND	772	83	644	45
LOW MODERATE	DISTRIBUTION LINE	2840	984	1515	341
LOW MODERATE	TWO-LANE PAVED ROAD	87	87		
LOW MODERATE	FOUR-LANE PAVED ROAD				
HIGH MODERATE	PUMP JACK	1010		905	105
HIGH MODERATE	DUMP				
HIGH MODERATE	SUBSTATION	68	68		
HIGH MODERATE	HOUSE	703	412	291	
HIGH MODERATE	TRANSMISSION LINE	815	32	768	15
HIGH MODERATE	RESERVOIR	1104	1104		
HIGH	RADIO TOWER	2348	2348		
HIGH	STORAGE TANK				
HIGH	FARM COMPLEX	613	482	131	
HIGH	MICROWAVE TOWER	2025			2025
HIGH	WATER TOWER				
HIGH	TOWN				
	TOTAL	13,369	5861	4804	2704

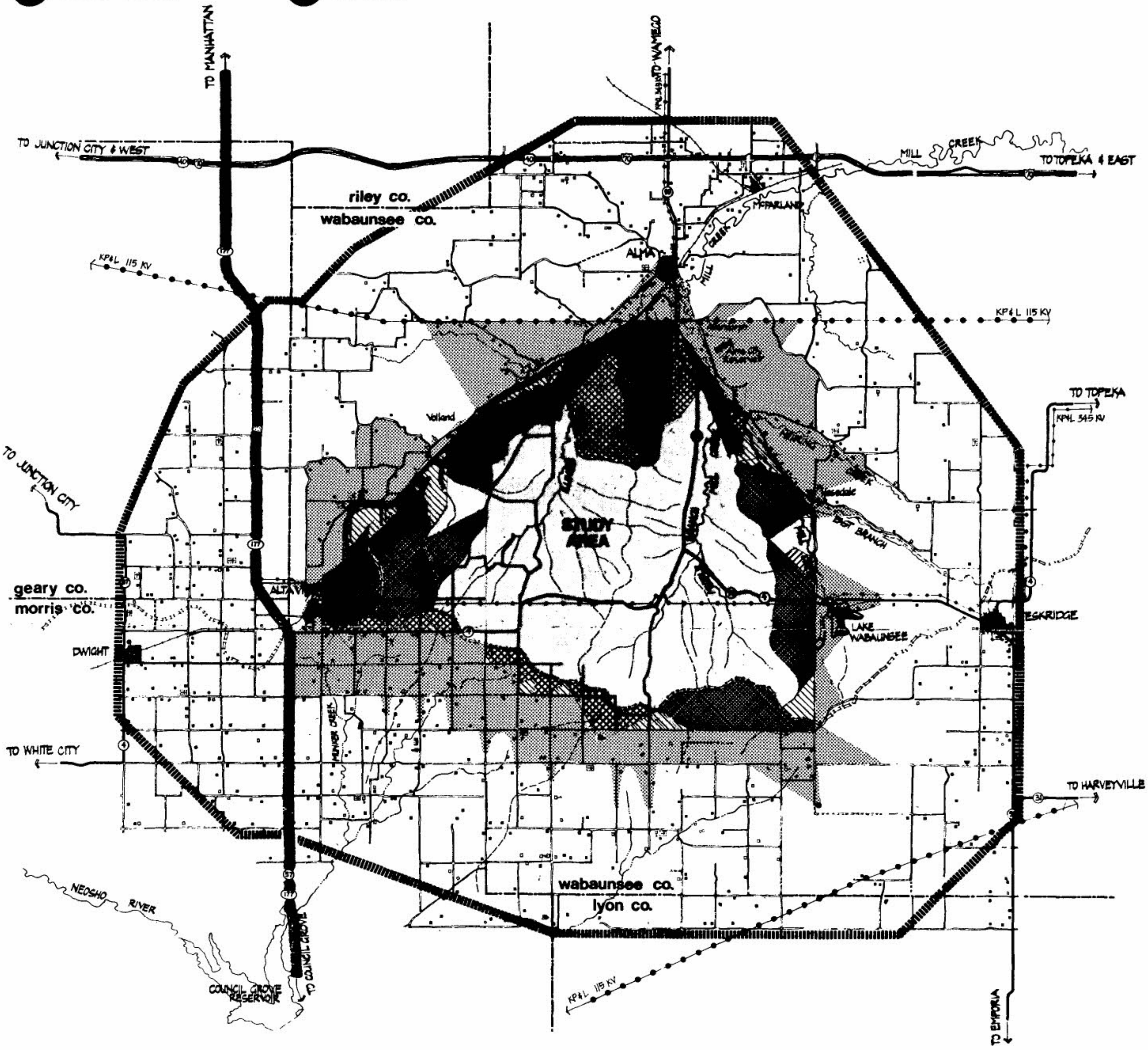
VISUAL DISTURBANCE — WABAUNSEE

		Total	Lowland	Transitional	Upland
LOW	DIRT ROAD	154	33	95	26
LOW	QUARRY	13		13	
LOW	AIRSTRIP				
LOW	GRAVEL ROAD	524	70	226	228
LOW	STONE FENCE	160		160	
LOW	RAILROAD				
LOW	CEMETERY				
LOW MODERATE	POND	308		238	70
LOW MODERATE	DISTRIBUTION LINE	1719	313	817	589
LOW MODERATE	TWO-LANE PAVED ROAD	710	39	518	153
LOW MODERATE	FOUR-LANE PAVED ROAD				
HIGH MODERATE	PUMP JACK	505		331	174
HIGH MODERATE	DUMP	11		11	
HIGH MODERATE	SUBSTATION	38		38	
HIGH MODERATE	HOUSE	1000	301	316	383
HIGH MODERATE	TRANSMISSION LINE				
HIGH MODERATE	RESERVOIR				
HIGH	RADIO TOWER				
HIGH	STORAGE TANK	181	66	115	
HIGH	FARM COMPLEX	2365	452	1070	843
HIGH	MICROWAVE TOWER				
HIGH	WATER TOWER				
HIGH	TOWN				
	TOTAL	7688	1274	3948	2466

visual disturbance levels

*Magnitude of visual disturbance:

High disturbance	High-moderate	Low-moderate	Low disturbance
town	transmission line	2-lane paved road	cemetery
water tower	reservoir	distribution line	railroad
complex	house	pond	gravel road
radio tower	oil field		



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA (within 6 miles)

WABAUNSEE

PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

031 | 40051
DSC | MAY 75

0 1 2 4 6 miles

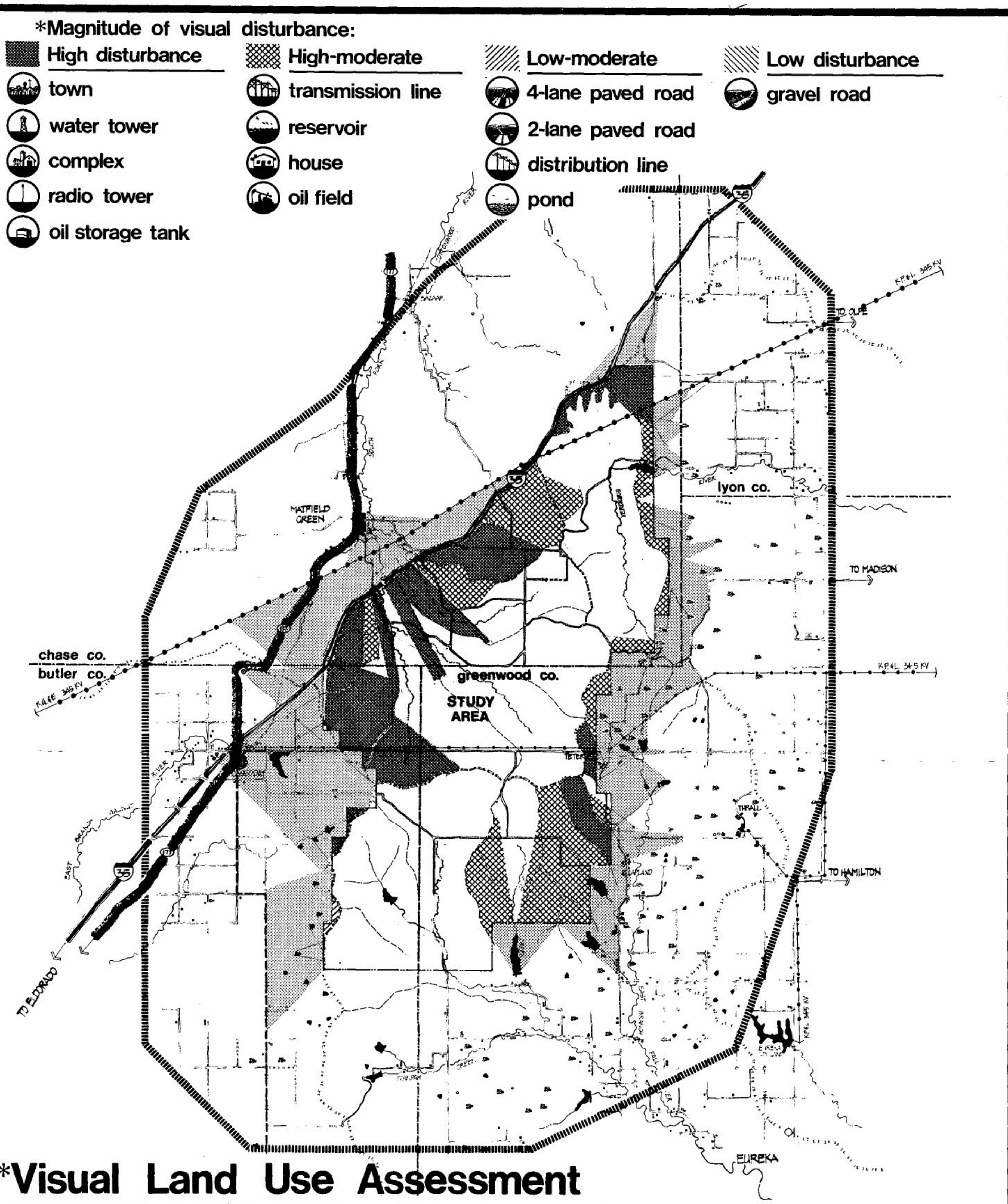
INTERSTATE HIGHWAY
U.S. HIGHWAY
STATE HIGHWAY
PRAIRIE PARKWAY
LOCAL ROAD, PAVED
LOCAL ROAD, GRAVEL
PRIMITIVE ROAD
RAILROAD
ABANDONED RAILROAD
RAILROAD STATION

AIRPORT, COMPLETE FACILITIES
AIRFIELD, LIMITED FACILITIES
LANDING AREA OR STRIP
INTERMITTENT STREAM
PERENNIAL STREAM
RIDGELINE
RESERVOIR

IN USE VACANT
FARM UNIT W/ DWELLING
CHURCH
CEMETERY
CHURCH W/ CEMETERY
SCHOOLHOUSE
TOWNHALL OR COMMUNITY HALL
SMALL BUSINESS OR FACTORY
GASOLINE FILLING STATION
WATER STORAGE TOWER

OIL WELL
OIL FIELD
PUMPING STATION
STOCK YARD
QUARRY
COMMUNICATION TOWER
TRANSMISSION LINE

ON MICROFILM



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA (within 6 miles)

CHASE

PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

0 1 2 4 6 miles

031 DSC 40052 MAY 75

INTERSTATE HIGHWAY
U.S. HIGHWAY
STATE HIGHWAY
PRAIRIE PARKWAY
LOCAL ROAD, PAVED
LOCAL ROAD, GRAVEL
PRIMITIVE ROAD
RAILROAD
ABANDONED RAILROAD
RAILROAD STATION

AIRPORT, COMPLETE FACILITIES
AIRFIELD, LIMITED FACILITIES
LANDING AREA OR STRIP

INTERMITTENT STREAM
PERENNIAL STREAM
RIDGELINE
RESERVOIR

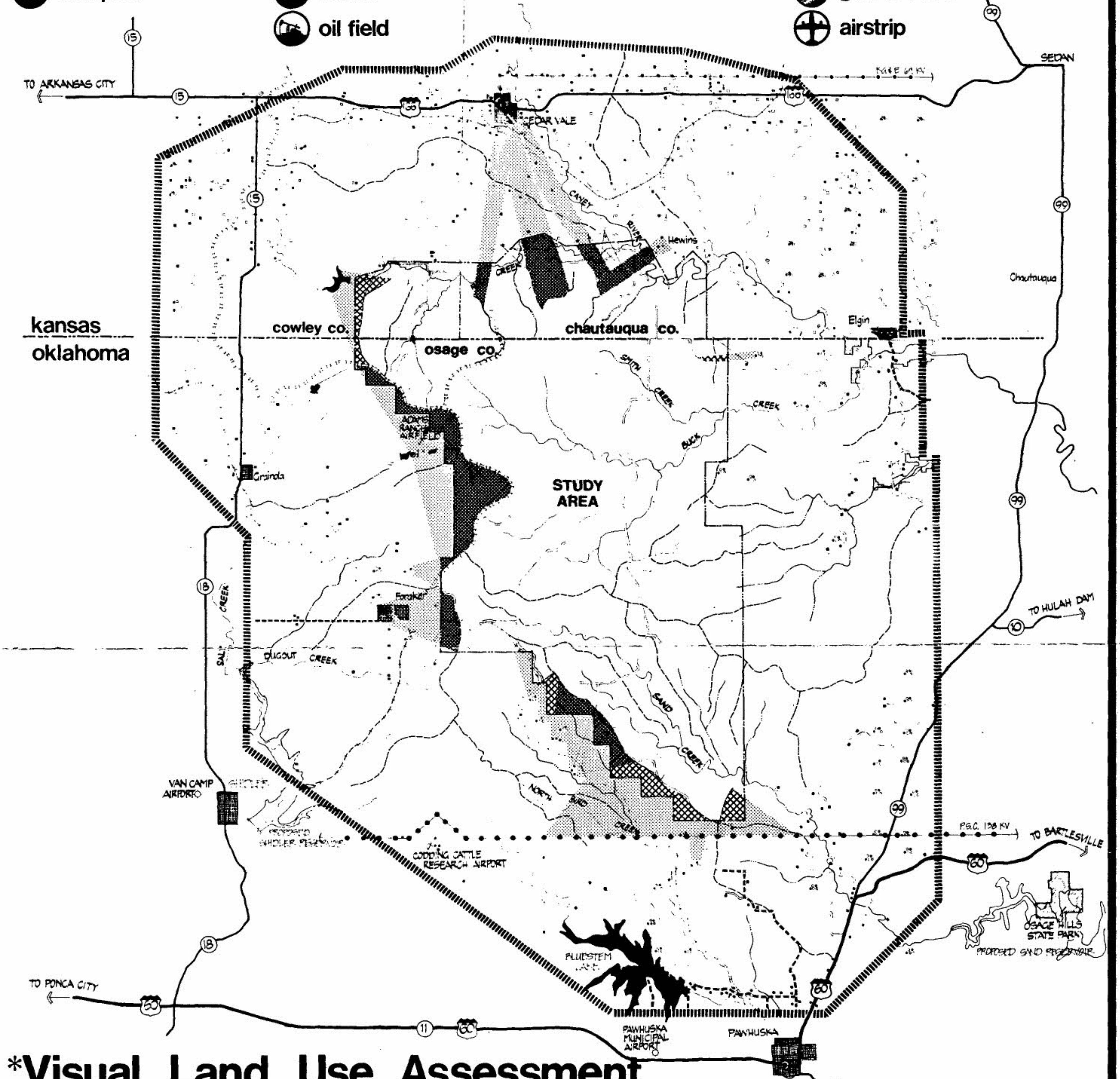
IN USE VACANT
FARM UNIT W/ DWELLING
CHURCH
CEMETERY
CHURCH W/ CEMETERY
SCHOOLHOUSE
TOWNHALL OR COMMUNITY HALL
SMALL BUSINESS OR FACTORY
GASOLINE FILLING STATION
WATER STORAGE TOWER

OIL WELL
OIL FIELD
PUMPING STATION
STOCK YARD
QUARRY
COMMUNICATION TOWER
TRANSMISSION LINE

MICROFILM

*Magnitude of visual disturbance:

High disturbance	High-moderate	Low-moderate	Low disturbance
town	transmission line	2-lane paved road	cemetery
water tower	reservoir	pond	railroad
complex	house		gravel road
	oil field		airstrip



*Visual Land Use Assessment

EXISTING LAND USE - SURROUNDING AREA

(within 6 miles)

OSAGE

PRAIRIE NATIONAL PARK STUDY

United States Department of the Interior / National Park Service

PRAI | 40053
D6C | MAY 75

0 1 2 4 6 miles

INTERSTATE HIGHWAY	AIRPORT, COMPLETE	FARM UNIT W DWELLING	OIL WELL
U.S. HIGHWAY	AIRFIELD, LIMITED	CHURCH	OIL FIELD
STATE HIGHWAY	LANDING AREA OR STRIP	CEMETERY	PUMPING STATION
PRAIRIE PARKWAY		CHURCH W/ CEMETERY	STOCK YARD - LOADING PEN OR CORRAL
LOCAL ROAD, PAVED		SCHOOLHOUSE	QUARRY
LOCAL ROAD, GRAVEL		TOWNHALL OR COMMUNITY HALL	COMMUNICATION TOWER
PRIMITIVE ROAD	INTERMITTENT STREAM	SMALL BUSINESS OR FACTORY	TRANSMISSION LINE - OVERHEAD
RAILROAD	PERENNIAL STREAM	GASOLINE FILLING STATION	
ABANDONED RAILROAD	RIDGELINE	WATER STORAGE TOWER	
RAILROAD STATION	RESERVOIR		

ON MICROFILM

VISUAL DISTURBANCE SUMMARY

PROPOSED PRAIRIE NATIONAL PARK STUDY

table 5

	LOW	LOW MODERATE	HIGH MODERATE	HIGH	TOTAL
WABAUNSEE					
STUDY AREA	LEAST	AVERAGE	AVERAGE	AVERAGE	AVERAGE
6-MILE	MOST	AVERAGE	AVERAGE	AVERAGE	AVERAGE
TOTAL	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
CHASE					
STUDY AREA	AVERAGE	MOST	MOST	MOST	MOST
6 – MILE	LEAST	MOST	MOST	MOST	MOST
TOTAL	LEAST	MOST	MOST	MOST	MOST
OSAGE					
STUDY AREA	MOST	LEAST	LEAST	LEAST	LEAST
6 – MILE	AVERAGE	LEAST	LEAST	LEAST	LEAST
TOTAL	MOST	LEAST	LEAST	LEAST	LEAST

(horizontal lines) MOST

(diagonal lines) LEAST

(dotted) AVERAGE

OIL, GAS, AND MINERAL EVALUATION
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
James E. Fox and John D. Wells
Central Region
Geological Survey
United States Department of the Interior

CONTENTS

MAPS

ILLUSTRATIONS

WABAUNSEE STUDY AREA

OIL AND GAS EVALUATION

The Wabaunsee study area is located on the west side of the Forest City basin in Wabaunsee County, eastern Kansas (see PRAI 40,072). Current oil production within the area occurs in two fields, Davis Ranch and Mill Creek (see PRAI 40,073).

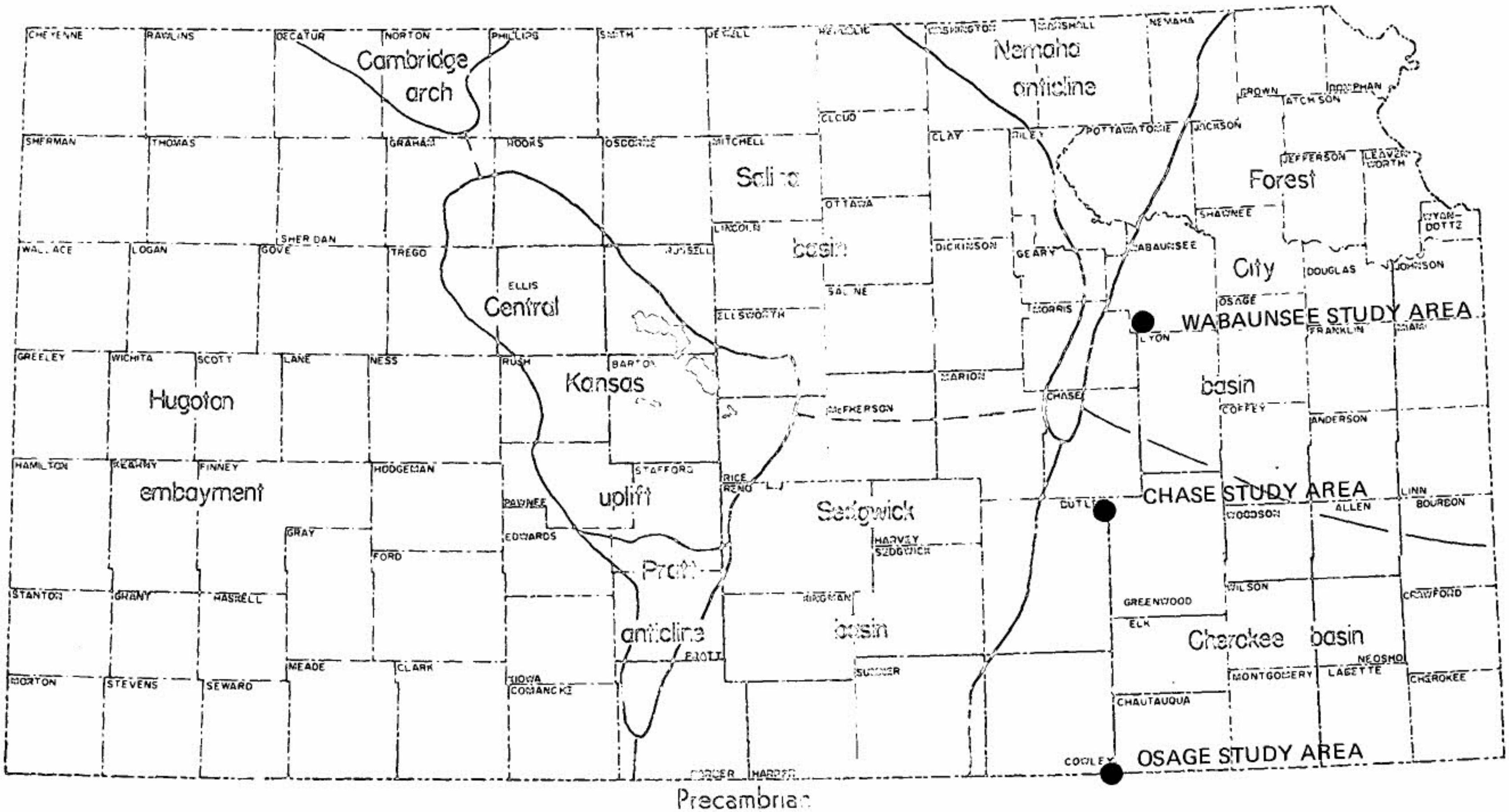
The Davis Ranch pool is an Ordovician pool discovery drilled in 1949 by Carter Oil Company. The oil occurs in the upper part of weathered Viola limestone along a disconformity below the Maquoketa shale (see Stratographic Section, Wabaunsee Study Area). The Viola limestone is middle Ordovician in age and ranges up to about 300 feet in thickness in eastern Kansas. The discovery well was drilled on the crest of an anticline mapped from outcropping rocks. This structure lies within the synclinal area of the Forest City basin just east of the Nemaha anticline (see PRAI 40,072 and 40,074). The Davis Ranch anticline has approximately 80 feet of closure on the Viola limestone and has dimensions at least ¾ mile wide and 2 miles long. Production from the discovery well was encountered at 3,201 feet.

In 1951, a new producing zone was found in the Davis Ranch field in the "Hunton" limestone at a depth of 2,929 feet. The "Hunton Group" in Kansas ranges in age from mid-Silurian to mid-Devonian (see Stratographic Section, Wabaunsee Study Area). The Davis Ranch anticline structure is faulted in the subsurface on its east side. A small oil pool, Davis Ranch East, was found in the Viola limestone in 1950, east of the fault and on its downthrown side. It was abandoned in 1950.

The Mill Creek pool, discovered in 1950, is located to the north and east of the Davis Ranch pool (see PRAI 40,073). It produces from the upper Viola at a depth of from 2,923 to 2,927 feet. It is located on an anticline on the same trend as the Davis Ranch pool, paralleling the large Nemaha anticline.

Much surface mapping, core drilling, and geophysical work followed the Davis Ranch oil field discovery. As shown on PRAI 40,073, numerous wells have been drilled and most of the known structures have been tested. The limits of production have probably been determined.

Cumulative production from the Davis Ranch pool reached about 6 million barrels of oil in 1973. Yearly production from 15 wells in the field reached a maximum of 430,000 barrels of oil in 1972. Production declined to 330,000 barrels of oil from 10 wells in 1974, and the curve indicates that it may continue to decline. However, yearly production *per well* has been increasing since 1971. Two wells from the field were put under secondary recovery in 1968. One new well was put under secondary recovery in



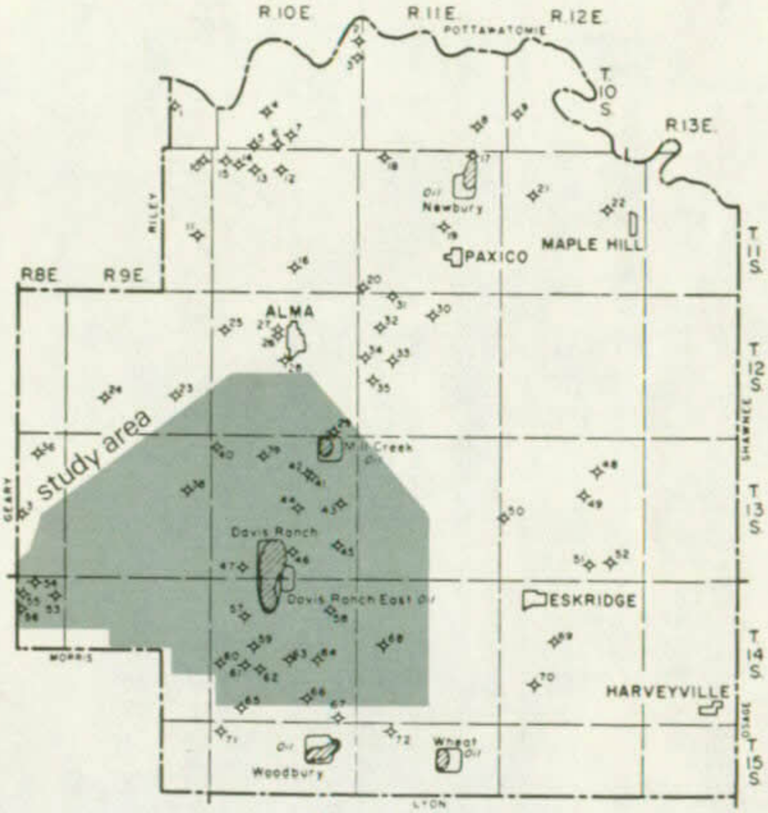
PRECAMBRIAN FORMATIONS KANSAS

SOURCE: STATE GEOLOGICAL SURVEY OF KANSAS
OIL & GAS INVESTIGATIONS NO. 16
PLATE 2

PRAI | 40072
DSC | JUNE

UNITED STATES DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

ON MICROFILM



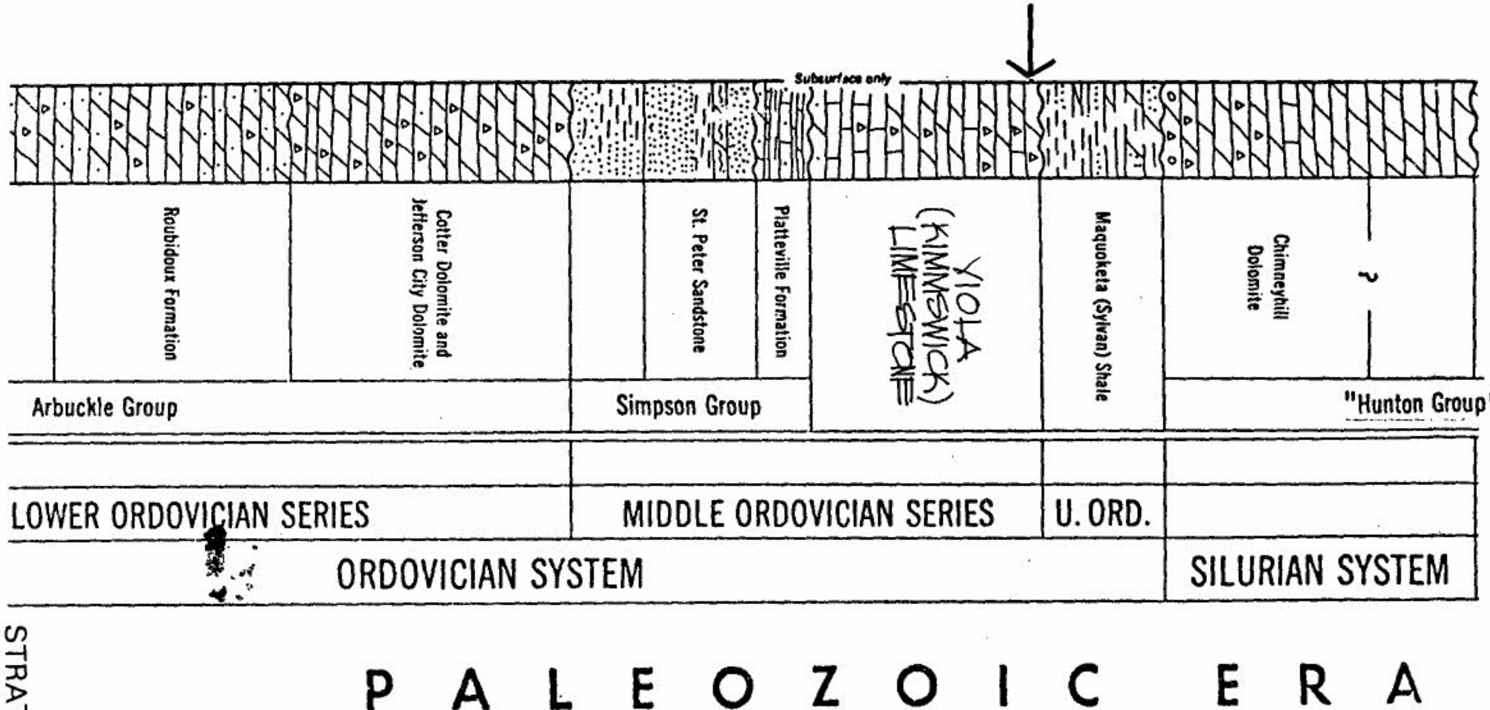
OIL EXPLORATION WABAUNSEE COUNTY

SOURCE: STATE GEOLOGICAL SURVEY OF KANSAS
OIL & GAS IN EASTERN KANSAS
BULLETIN 104 FIG. 55

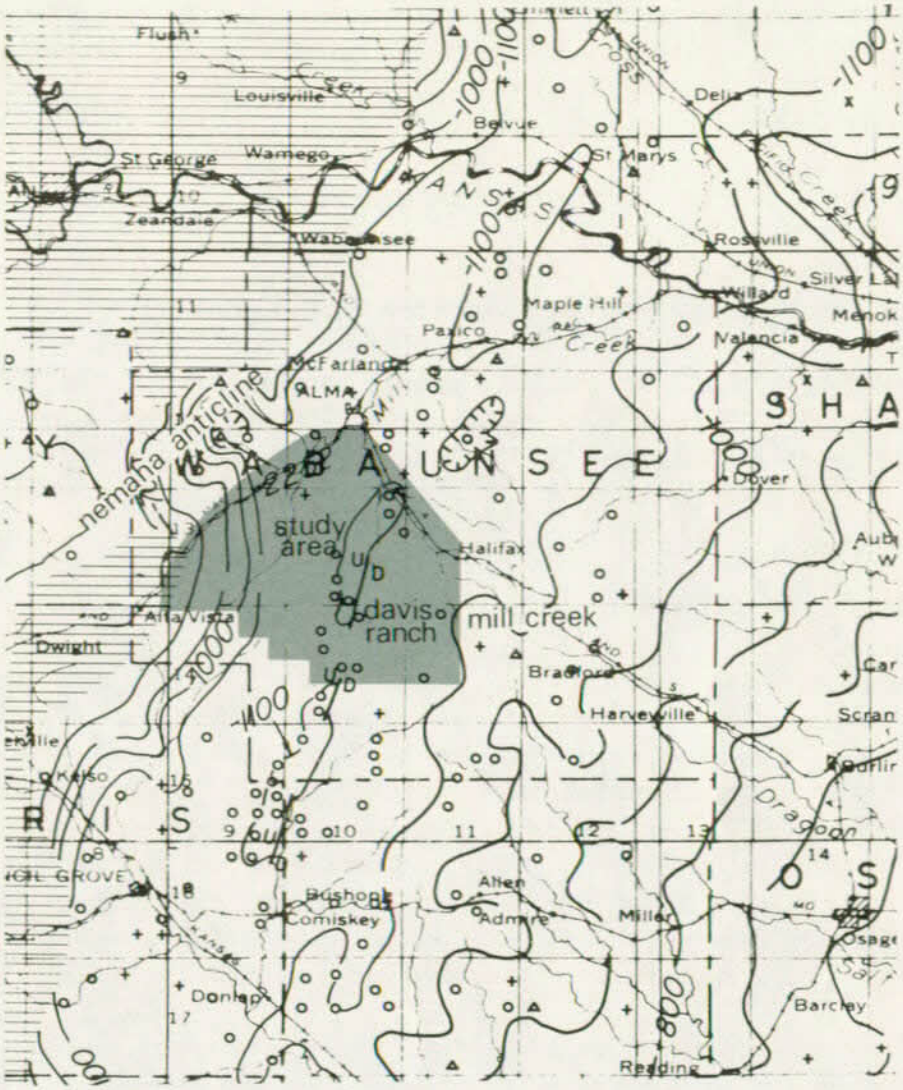
031
[redacted] 40073
DSC | JUNE

UNITED STATES DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

ON MICROFILM



STRATOGRAPHIC SECTION,
WABAUNSEE STUDY AREA



CONTOURS DRAWN ON TOP
OF MISSISSIPPIAN

STRUCTURAL CONTOUR MAP
WABAUNSEE COUNTY, KANSAS

SOURCE: STATE GEOLOGICAL SURVEY OF KANSAS
OIL & GAS INVESTIGATIONS NO. 22

031
[redacted] | 40074
DSC | JUNE

UNITED STATES DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

ON MICROFILM

1971. A maximum of 14,000 barrels of oil were recovered in 1970, with production declining to 13,000 barrels in 1971 from the three wells. It is anticipated that the Davis Ranch field will go under secondary recovery after primary production is completed, probably within the next 10 years.

Cumulative production from the Mill Creek pool reached 390,000 barrels of oil in 1974. Yearly production for the field reached a peak of about 36,000 barrels of oil from four wells in 1952. Production declined to about 5,000 barrels of oil from four wells in 1968 and has remained at that level to the present. Waterflooding was started in 1967, but no production has been credited to this technique.

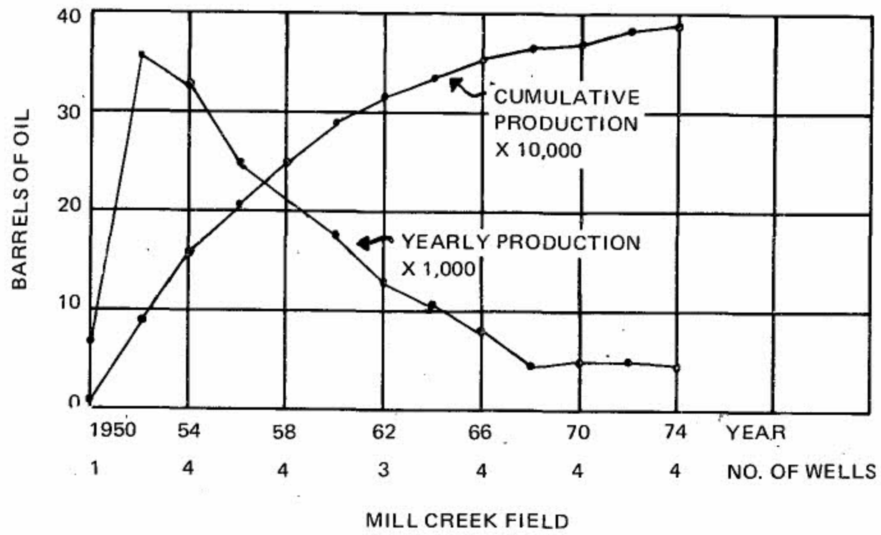
Production from Davis Ranch and Mill Creek accounted for 0.6 percent of total Kansas production in 1972. Gross income from the two fields, calculated using a $10 per barrel price, totals approximately 3.5 million dollars annually at 1974 production rates.

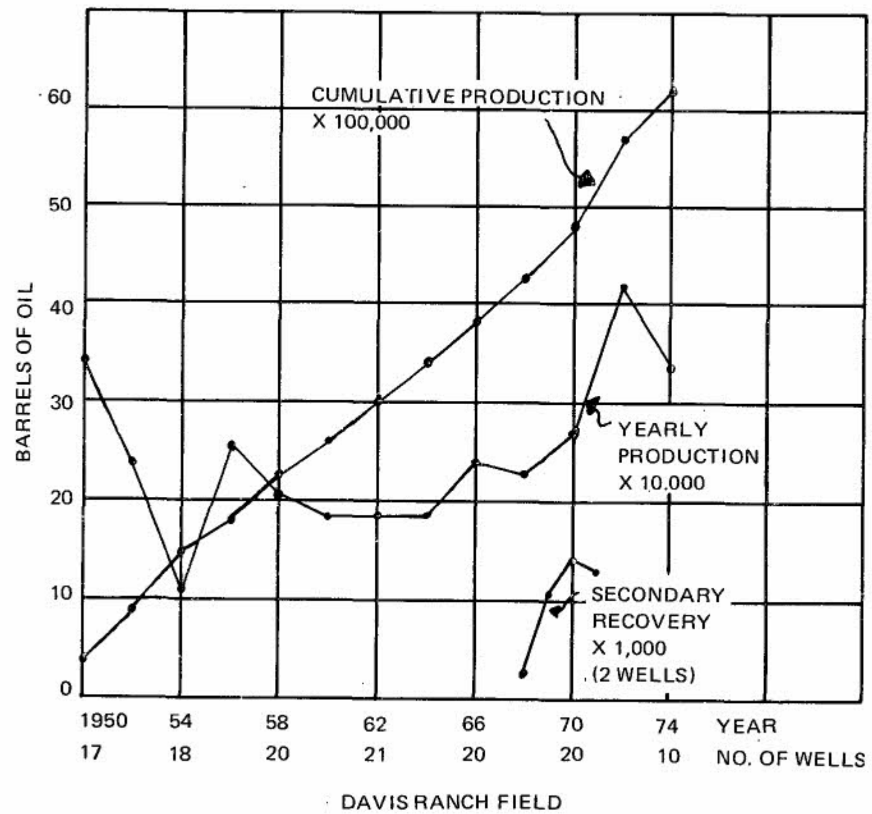
MINERAL EVALUATION

The outcropping bedrocks in the study area are a nearly flat (dipping slightly to the west) sequence of Permian limestone and shale about 400 feet thick. The Fort Riley limestone is the uppermost formation, and the Roca shale is the lowermost. None of the formations in this interval exceed 40 feet in thickness. The limestones are mostly gray and massive-to-thin-bedded, with shale partings; some are cherty. The shales, silty and calcareous, are colored various shades of gray, green, tan, and red. The bedrock units are overlain by thin (generally less than 50 feet), unconsolidated deposits of valley alluvium (consisting of silt, clay, sand, and gravel) and accumulations of residual chert gravel, silt, and clay mixed with windblown silt on upland surfaces.

These unconsolidated deposits have been used locally as sources of sand and gravel for aggregate and road metal, and some of the massive limestones are suitable for structural stone, riprap, agricultural lime, and aggregate when crushed. Some are suitable for chemical uses. Some of the shale is probably suitable for ceramics material. None of these are economically important for large-scale operations because all of these materials are available at other sites near transportation and markets.

Thin, impure coal seams (generally less than ½ foot) are present in rock units at depths in excess of 150 feet within the study area. These coal seams are not economical where they outcrop east of the area; therefore, they are probably not of economic significance in the study area.





PRODUCTION HISTORY
WABAUNSEE STUDY AREA
OIL FIELDS

SUMMARY

Much surface mapping, core drilling, and geophysical work throughout the country has followed the discovery of the Davis Ranch pool in 1949. The oil is structurally trapped within the area, and most of the known structures have been tested; the limits of production within the area have probably been determined and little future potential is predicted.

The distribution of wells drilled in the area is relatively sparse, and potential problems associated with abandoned well bores should be minimal.

The two small fields in the area have only 14 operating wells (1974); removal of electrical powerlines that provide energy for pumps should be fairly easy. The small size of the fields generally means less cluttering of the area with drilling, maintenance, and storage equipment.

There are no pipelines within the area of study and no surface rights are required for maintenance.

Production from the Mill Creek field is stabilized at about 5,000 barrels of oil per year and has very limited future oil production potential. It has been under waterflooding since 1967, but no production is credited to this recovery technique. Unlike the fairly unproductive Mill Creek field, the Davis Ranch field has the greatest primary production and the greatest potential for secondary recovery production of all fields in the three areas under study. During 1974, production from Davis Ranch field was projected to be about 330,000 barrels of oil from 10 producing wells. At a projected rate of $10 per barrel of crude oil, the field could gross over 3 million dollars per year at present production rates. Production from the field in 1972, when it was near peak production, accounted for 0.6 percent of total Kansas oil production for that year.

It has been demonstrated that the Davis Ranch field will perform well under secondary recovery, and it is anticipated that the field will have a long-term productive future of secondary recovery operations.

CHASE STUDY AREA

OIL AND GAS EVALUATION

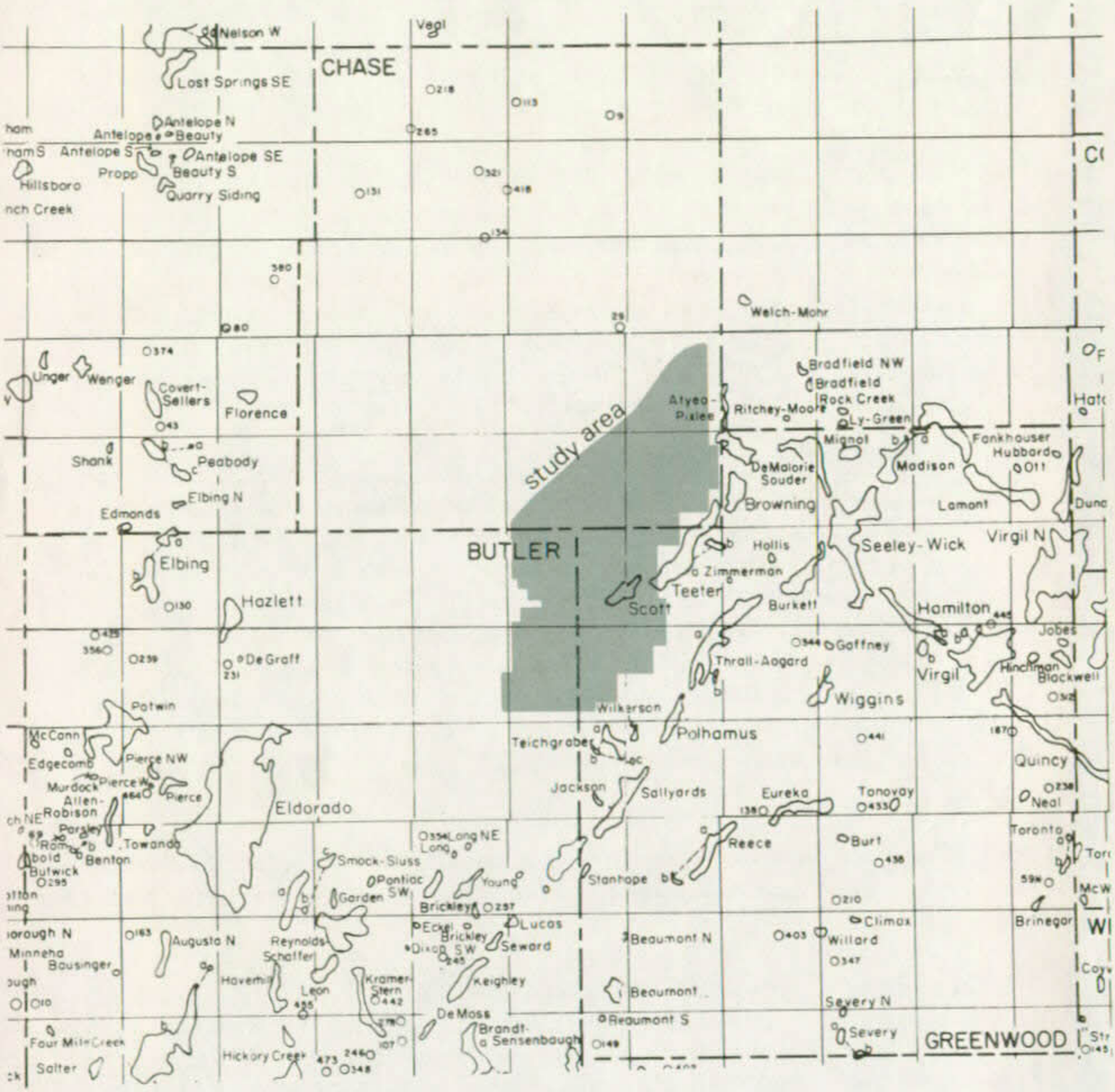
The Chase study area is located on the western side of the Cherokee basin and in Chase, Butler, and Greenwood Counties, eastern Kansas (see PRAI 40,072). Current oil production within the area occurs from Scott field and the southwestern end of Teeter field (see PRAI 40,075). The Scott oil field was opened in 1925 and the Teeter oil field was opened in 1921. Both fields are stratographic traps in the Teeter trend, with the Burbank sand (often called "Bartlesville" but younger than that) as the reservoir at an average depth of about 2,500 feet. The average thickness of the sand body exceeds 50 feet, and as much as 130 feet has been reported.

No structural entrapment occurs in the area. The Burbank and Bartlesville are "shoestring" sands surrounded by shale of the middle Pennsylvania Cherokee group (see Stratographic Section, Chase Study Area). These sands are actually zones composed of numerous lenses of sand that occur within narrowly restricted limits in the Cherokee shale, the source of hydrocarbons that migrated into the sands. These sand bodies occur in trends up to 50 miles long made up of discontinuous lenses of sand 50 to 150 feet thick, ½ to 2 miles wide, and 2 to 6 miles long, separated by gaps with no sand similar to offshore bars of the Atlantic and Gulf coasts. They represent lines of beach growth and a series of overlapping beaches on the western shore of the Cherokee sea preserved as ridges of sand trending parallel with the coast (see PRAI 40,076).

The demonstrated restricted limits of "shoestring sands" and the dense distribution of wells in the area indicate that the limits of production for this interval have probably been determined.

The Scott field has been under waterflood since 1945. Peak recovery was 112,000 barrels of oil in 1954 from 38 wells. Production declined to 15,000 barrels of oil from 11 wells in 1968 and rose to about 50,000 barrels from 10 wells in 1970. Production decreased to about 18,000 barrels from 12 wells in 1974. If this declining trend continues, most of the oil in the reservoir will be depleted by 1980. Using an estimated price of $10 per barrel, Scott field would gross $180,000 per year at 1974 production rates.

The Teeter field has been under waterflood since 1947. However, production figures for secondary versus primary recovery were not available until 1962. Yearly production reached a maximum of about 410,000 barrels of oil from 154 wells in 1960. Production generally declined to about 100,000 barrels of oil from 115 wells in 1974. As indicated, the secondary recovery has been quite effective, and it is difficult



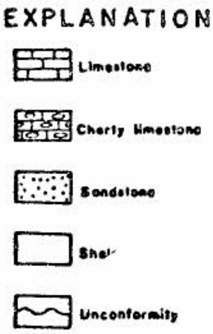
OIL FIELDS
CHASE STUDY AREA

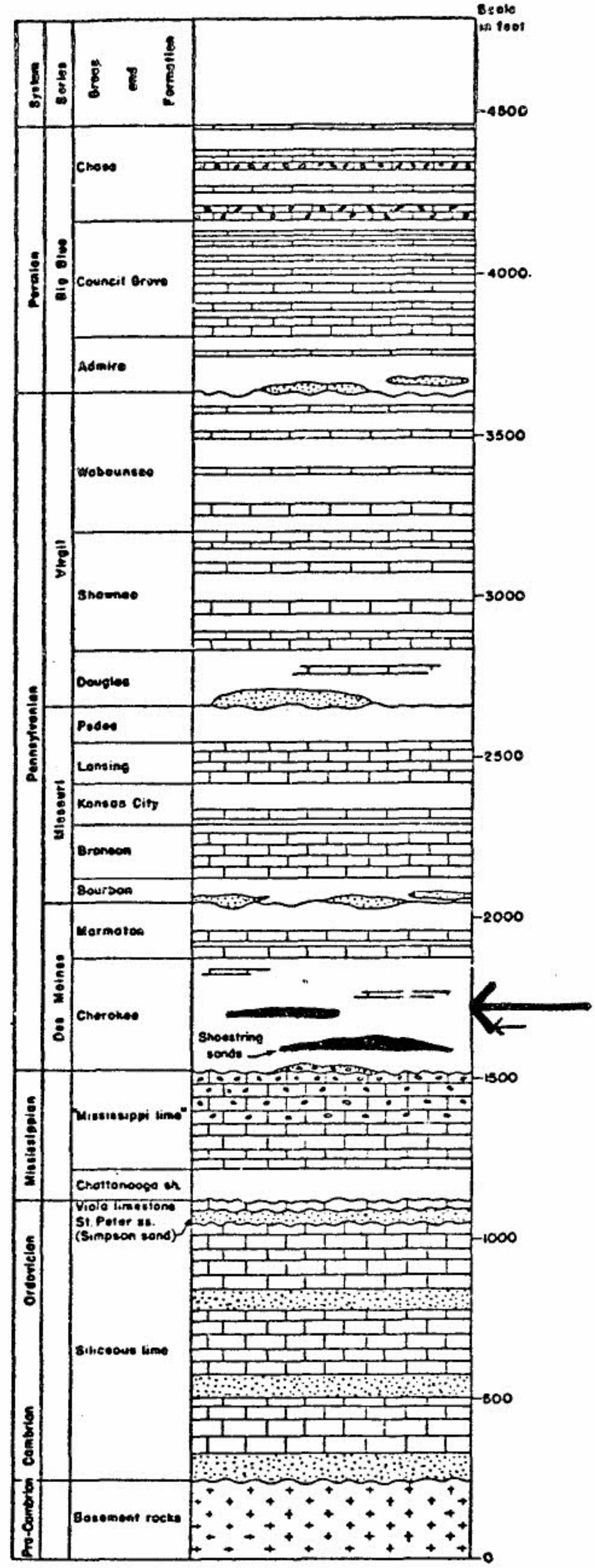
SOURCE: KANSAS STATE GEOLOGICAL SURVEY
OIL & GAS INVESTIGATIONS NO. 16
PLATE 1

031
40075
DSC | JUNE

UNITED STATES DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

ON MICROFILM





STRATOGRAPHIC SECTION
CHASE STUDY AREA

SOURCE:
STATE GEOLOGICAL
SURVEY OF KANSAS
BULLETIN 23
FIG. 2

to project from the production curves when the reservoir will become depleted. Only the southwestern end of Teeter field, however, lies within limits of the study area.

Teeter field and Scott field combined accounted for only 0.14 percent of total Kansas oil production in 1972.

MINERAL EVALUATION

The outcropping bedrocks in the study area are a nearly flat (dipping slightly to the west) sequence of Permian limestones and shales about 475 feet thick. The Fort Riley limestone is the uppermost formation and the Hamline shale is the lowermost. None of the formations exceed 40 feet in thickness. The limestones are mostly gray and massive-to-thin-bedded with shale partings; some are cherty. The shales are silty and calcareous and are colored various shades of gray, green, tan, and red. The bedrock units are overlain by thin (generally less than 50 feet), unconsolidated deposits of valley alluvium consisting of silt, clay, sand, and gravel and accumulations of residual chert gravel, silt, and clay mixed with windblown silt on upland surfaces.

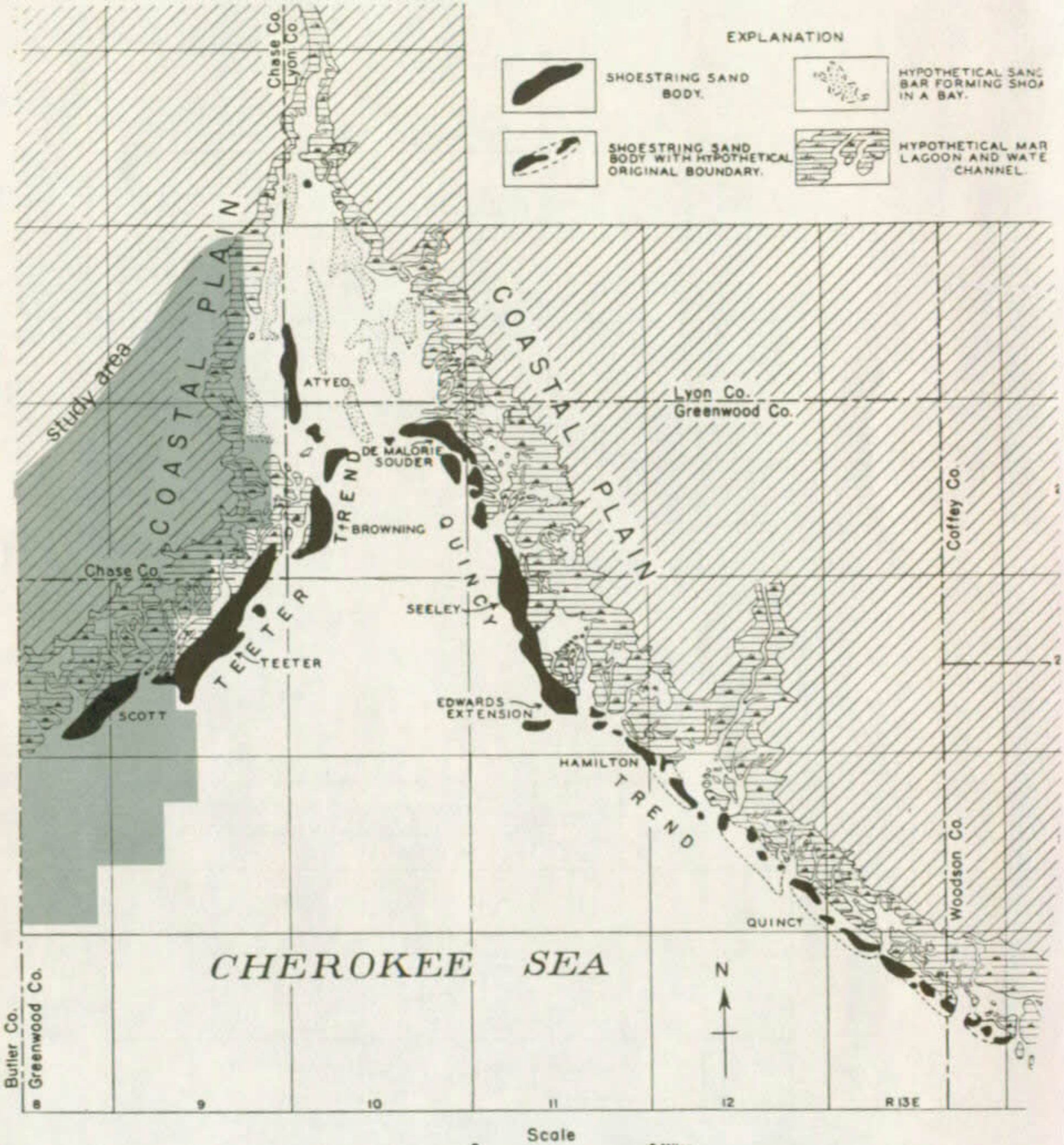
These unconsolidated deposits have been used locally as sources of sand and gravel for aggregate and road metal, and some of the massive limestones are suitable for structural stone, riprap, agricultural lime, and aggregate when crushed; some are suitable for chemical uses. Some of the shale is probably suitable for ceramics material. None of these are economically important for large-scale operations because all of these materials are available at other sites near transportation and markets.

SUMMARY

Much drilling throughout the area and demonstrated restricted limits of the productive "shoestring sands" have resulted in well-defined limits of production. Future potential for discovering new oil in the area from "shoestring sands" is minimal. Formations that have not been tested in the area include the Viola and Simpson; when productive in other areas, these formations produce from structural traps. Structural contour maps indicate the Chase area to be on a flat trend with little potential for structural entrapment.

Production from Scott field was about 18,000 barrels of oil in 1974 and is declining; Scott field accounted for only 0.06 percent of total Kansas oil production in 1970. Scott field has been under waterflooding for about 20 years and production is rapidly declining. Future production from the field may be very limited.

Only the extreme southwest end of the Teeter field lies in the study area and very little of its production has come from within the study area.

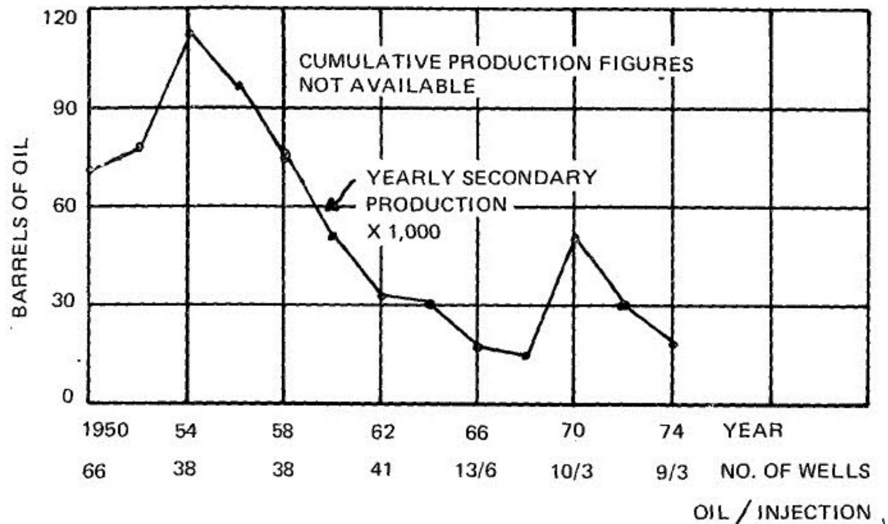


OIL-BEARING FORMATIONS
CHASE STUDY AREA

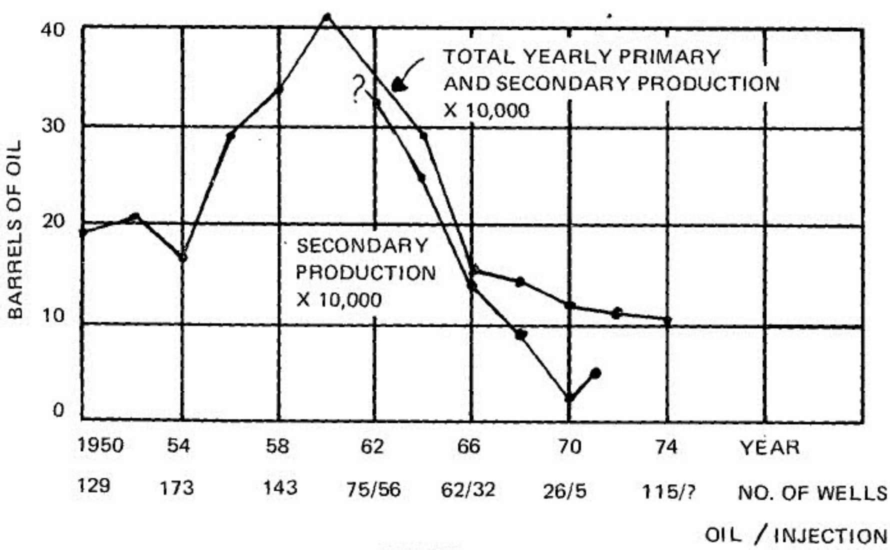
SOURCE: STATE GEOLOGICAL SURVEY OF KANSAS
BULLETIN 23 PLATE 19

031
[redacted] 40076
DSC | JUNE

ON MICROFILM



SCOTT FIELD



TEETER FIELD

PRODUCTION HISTORY
CHASE STUDY AREA
OIL FIELDS

Due to the very dense distribution of abandoned and producing wells, there is a greater chance in this area than in the other areas of caving and leakage problems from improperly plugged and abandoned wells, many of which were drilled in the 1920s. Also, there are probably numerous electrical powerlines to contend with and more cluttering of this area with drilling, maintenance, and storage equipment and facilities.

Another aspect that merits some consideration is that of communication between reservoirs. Scott field, which lies within the area under study, is on trend with Teeter field, most of which does not lie within the area of study; there may be communication between the two reservoirs. If this is the case, it will be difficult to accelerate recovery of oil from one field (Scott) or part of one field (southwest end of Teeter) without affecting the production from Teeter field, most of which lies outside the study area.

There are several pipelines running through the area of study that may require surface access for maintenance.

Considering the nature of the "shoestring sands" and the relatively high gravity of the oil, potential for tertiary recovery is good.

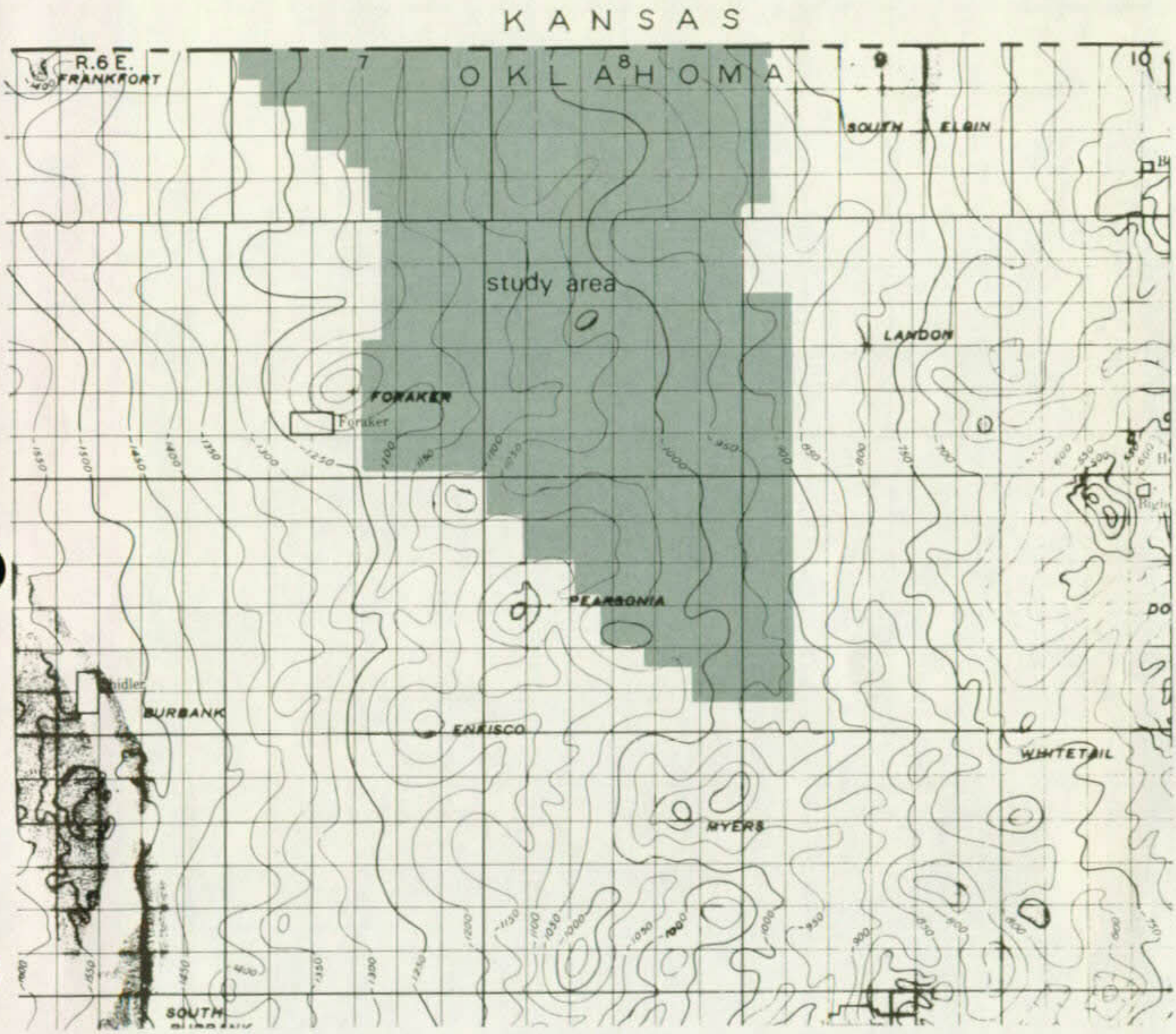
OSAGE STUDY AREA

OIL AND GAS EVALUATION

The Osage study area is located in Cowley and Chautauqua Counties, southeastern Kansas, and extends into Osage County, northeastern Oklahoma (see PRAI 40,072). Current oil production within the study area is restricted to Osage County, Oklahoma. Osage County is situated on the Prairie Plains monocline, a regional structural feature extending from Iowa to Texas. Although the regional dip is toward the west, the rocks have been deformed, and numerous domes, anticlines, and basins exist, especially in the eastern half of the county. The western half contains few folds. Since there is no major angular unconformity between the surface beds and the base of the Pennsylvanian, the structure on the surface conforms very well with the structure on most of the Pennsylvanian producing horizons. For this reason, surface structure has been one of the most important criteria for choosing drill sites.

Oil in the area is produced from the Burgess-Mississippi zone. The Burgess sand occurs in the lowermost part of the Pennsylvania (Des Moines) Cherokee shale, and thus immediately overlies the old erosion surface of the Mississippian Mississippi lime. It has been difficult to determine definitely in which, if not both, of these units the oil occurs; thus, the term Burgess-Mississippi zone is used for oil occurring in beds at or near the contact. Production from this interval in the area is the result of structural entrapment. The main northeastward-trending belt of domes and anticlines lies to the east and southeast of the study area. The producing fields in the study area include Dog Creek, Northeast Blackland, Northeast Pearsonia, and Landon West (see PRAI 40,078). Total daily production from these fields, as of June 1974, was about 100 barrels per day from the Burgess-Mississippi zone. No other zones have been producing within the area. Much recent activity has been demonstrated around the margins, and future activity may extend into the study area. Anticipated exploration activity in western Osage County with objectives of the Layton, Cleveland, Skinner, Red Fork, Mississippi, and Ordovician may include the area of study.

Fields within the Osage study area include Dog Creek (opened in 1956), Northeast Blackland (opened in 1955), Northeast Pearsonia (opened in 1969), and Landon West (opened in 1973). Daily production is increasing in all the fields except Dog Creek. Total cumulative production from these fields with 11 producing wells reached about 245,000 barrels of oil in 1974. Total production for 1974 was about 35,000 barrels of oil. At an estimated price of $10 per barrel, these fields could gross $350,000 per year at 1974 production rates.



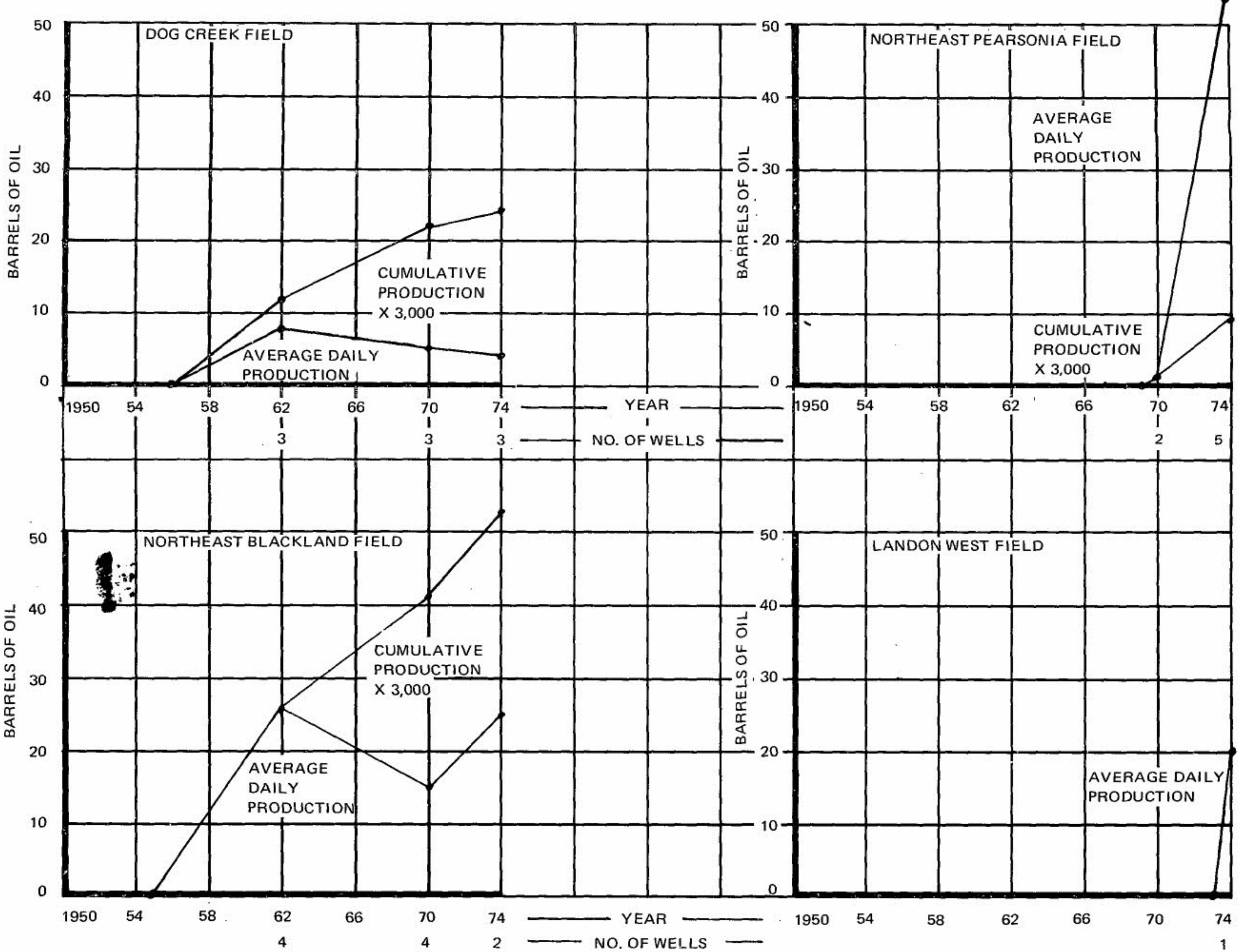
OIL FIELDS

OSAGE STUDY AREA

SOURCE: USGS BULLETIN 900
PLATE 15

031
[redacted] 40078
DSC | JUNE

ON MICROFILM



PRODUCTION HISTORY - OSAGE STUDY AREA OIL FIELDS

MINERAL EVALUATION

The outcropping bedrocks in the study area are a nearly flat (dipping slightly to the west) sequence of Permian limestones and shales and Pennsylvanian limestone, shale, sandstone, and minor coal about 1,200 feet thick. The Grenola limestone is the uppermost formation, and the Vamoosa formation, equivalent to the Shawnee and Douglas groups, is the lowermost. None of the formations exceeds 80 feet. The bedrock units are overlain in the valleys by thin – generally less than 50 feet – alluvium consisting of silt, clay, sand, and gravel.

These unconsolidated deposits have been used locally as sources of sand and gravel for aggregate and road metal, and some of the massive limestones are suitable for structural stone, riprap, agricultural lime, and aggregate when crushed. Some are suitable for chemical uses. Some of the shale is probably suitable for ceramics material. None of these are economically important for large-scale operations because all of these materials are available at other sites near transportation and markets.

Thin coal seams crop out in the Wabaunsee group; these are mostly less than 6 inches thick. Mining did occur northwest of the study area at the turn of the century in a locally thick seam, about 18 inches thick. No mining has occurred since 1940.

The rocks that contain coal and lead-zinc mineralization in southeastern Kansas and northeastern Oklahoma extend westward under the study area at depths of 1,000 to 5,000 feet. These are deep, have not been explored, and probably have little economic potential.

SUMMARY

Very little oil production occurs from within the area of study. The yearly production for 1974 is estimated to be about 35,000 barrels of oil from four oil fields.

The density of abandoned and producing wells is sparse within the area, and most of the wells have been drilled fairly recently; therefore, few problems associated with abandoned well bores are anticipated.

The fields within the area have few wells; problems with electrical powerlines to pumps and cluttering of drilling, maintenance, and storage equipment and facilities in the area should be minimal.

There are several pipelines running through the area that may require surface access for maintenance.

Daily production from the four fields in the area is only about 100 barrels of oil from the Burgess-Mississippi zone. Recovery of oil from this zone has been difficult, and daily production figures may not adequately reflect the quantity of reserves in the area. Increased exploration activity could be expected in the area if improved recovery techniques are developed. Because of the recovery problems, accelerated development of the area may be difficult.

Fairly recent accelerated drilling activity has occurred around the area of study, and future activity may extend into the area to test unevaluated potential structural traps. Anticipated exploration activity in western Osage County with objectives of the Layton, Cleveland, Skinner, Red Fork, Mississippi, and Ordovician may include the area under study.

BIBLIOGRAPHY

CLINTON, R.P.

1957 "The Geology of the Osage Country." *Shale Shaker,* vol. 8, no. 2.

STATE GEOLOGICAL SURVEY OF KANSAS

1945 "Oil and Gas in Eastern Kansas." Bulletin 57.

1949 "Oil and Gas in Eastern Kansas," by J.M. Jewett. Bulletin 77.

1958 "Producing Zones of Kansas Oil and Gas Field," by P.L. Hilpman. Oil and Gas Investigations bulletin 16.

U.S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

1936 "Origin of the Shoestring Sands of Greenwood and Butler Counties," by N.W. Bass. Kansas no. 23.

1942 "Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma," by N.W. Bass. USGS bulletin 900.

LANDOWNERSHIP

ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by

Robert Smith
Midwest Regional Office
National Park Service
United States Department of the Interior

CONTENTS

J: LANDOWNERSHIP

OK

STUDY OF LANDOWNERSHIP VALUES

PURPOSE

The purpose of this report is to estimate values of lands within three areas found to be nationally significant as possible Prairie National Park sites. These are referred to as the Wabaunsee, Chase, and Osage study areas.

INTEREST TO BE ACQUIRED

All interests to be acquired are fee simple interests.

DEFINITION OF VALUE

All values are based on fair market value. Fair market value is defined as the highest price that a property will bring if sold in the open market by a willing seller, allowing a reasonable time to find a buyer who is willing but not obligated to buy, with both parties having full knowledge of all uses for which it is adapted and for which it is capable of being used.

HIGHEST AND BEST USE

The highest and best use of all three areas is considered to be for agricultural purposes.

INSPECTION OF PROPERTY

Robert Smith, Chief Appraiser for the Midwest Regional Office of the National Park Service, made a general inspection of the three areas during the week of May 5, 1975. This was a hurried inspection (per instructions) and was made entirely from public roads.

LAND VALUES FOR PASTURELANDS, CROPLANDS, AND WOODLANDS

Values for various types of land are shown in the enclosures for the various study areas. These values include price escalation, court costs, appraisal, mapping, title and surveying costs.

LAND VALUE DIFFERENCES

In order to make an accurate study of values relative to the sizes of ownerships, a detailed sales analysis would be needed. This would involve studying public records of various sales that have taken place in the area during the past 2 or 3 years. Due to the nature of the suitability study, such detail was not possible nor deemed necessary at this point. Comparative gross values between the three study areas should be adequate for this study.

Indications are that some of the smaller tracts probably would sell for slightly more per acre than large tracts, particularly in the Wabaunsee area, which is closer to heavily populated areas. This is not always true, however, especially in regard to ranchlands; some ranch owners will pay more for properties in order to purchase adjoining land. In a general way, this evaluation includes the effect of the size of ownership on the overall valuation of the land.

DESCRIPTION OF THE AREA TO BE ACQUIRED

The Department of Landscape Architecture, Kansas State University, has made a fairly detailed study of the areas, including a calculation of croplands, grasslands, and woodlands (appendix G). Their figures were used as a basis for the breakdown in valuation. They also prepared maps and a written list of improvements located within each study area, although several improvements listed were outside of the study areas. Their list was used to count the improvements and to estimate the number of people that would be displaced.

VALUATION

In order to estimate the valuation of properties within the areas, several local appraisers were contacted for general information regarding various land values in the areas.

Although the study was briefly conducted, it is believed that total values are within a reasonable range. Values set forth include not only the estimated present value of the land but anticipated price escalation over the next 5 years. The estimated value includes estimates of the cost of acquiring part of the land through eminent domain, cost of relocation, and administrative costs. No valuation is included for oil well equipment, transmission lines, compressor stations, etc.

NUMBER AND SIZE OF OWNERSHIPS

Published county ownership maps secured through abstract companies indicate ownership of various parcels of land. These maps have been analyzed as a basis for lists of ownerships with approximate acreages. These data are included in this report.

TAX REVENUES

Without a detailed study of courthouse records, it is impossible to accurately estimate assessed value and tax loss to the counties involved. Very preliminary studies indicate that the Wabaunsee study area would have an assessed value of 3 to 3.5 million dollars and would cause an annual tax loss based on 1975 mil levy of $225,000 to $250,000 per year. The Chase study area is estimated to have an assessed value of 2.5 to 3 million dollars with a current tax loss for acquisition of this area of $175,000 to $200,000 per year. The Osage study area is estimated to have an assessed value of 2 to 2.5 million dollars with an estimated annual tax loss of $100,000 to $125,000.

The taxes on grassland in Osage County, Oklahoma, are lower than in the adjoining counties in Kansas. A reassessment of this area, which would probably raise the taxes by as much as 50 percent, is expected in the near future.

ENCLOSURE 1: WABAUNSEE STUDY AREA

A. Landownership

B. Landownership Summary

C. Estimated Land Acquisition Cost

D. Suggested Planning Level for Land Acquisition

E. Relocation Assistance Payments Under Public Law 91-646

A: LANDOWNERSHIP

Wabaunsee Study Area

	Owner	Section	Acres	Severence
1.	Carl Mathies	21,22,28	320	no
2.	Ross Palenske	22	160	yes
3.	R.L. Schmidt	22,23	120	yes
4.	Zeckser	23	60	yes
5.	Walt Wilkinson	26,27	320	no
6.	F. Rice	26	120	yes
7.	C.L. Schewe	26	60	yes
8.	M.C. Schewe	35	70	yes
9.	W.H. Maike	26,34,35	500	no
10.	L. & W. Marten	26,27	240	no
11.	H.T. Morris	35,36	110	yes
12.	Stephen Anderson	35,34	320	no
13.	Geo. O. Egert	34,35	200	no
14.	Kath Lund	1	120	no
15.	Kilma Ringel	1	70	no
16.	Geo. E. & Wm. Schlecty	12,7	360	yes
17.	G. Sommer	7,18	360	yes
18.	John L. Frank	18	150	yes
19.	A. Meyer	17	80	yes
20.	O.J. Hess	20,19,24,15,22	1,160	no
21.	O.W. Hess	18,28,32,33,5, 4,3,8,17,18,16, 19,20,21,22	7,110	no
22.	C.A. Jory	24,25,19,30,20,29	1,160	no
23.	E.J. Anderson	29	160	no
24.	L.B. Anderson	20	240	no
25.	J.L. Treau	31,32,29	360	no
26.	E. Bohn	31,32	360	no
27.	Nancy Jo Jacobs	8	320	no
28.	Robert P. Warren	8	320	no
29.	Helen Egy	17,20	1,280	no
30.	Harlan Simon	27,34	520	no
31.	L.E. Mogge	2,28	160	no
32.	Leslie Blanton	29	200	yes
33.	A.H. Dieball	29,30	480	yes
34.	Mrs. F. Thowe	9	300	no
35.	F. Bandel	9,16	240	no

	Owner	Section	Acres	Severence
36.	Marie Schewe	9,16,10	240	no
37.	Hermagene Lacy	16,15	540	no
38.	Harry M. Thowe	10	260	no
39.	C. Thowe	3,2	760	no
40.	Daniel B. Robertson	1,12	320	no
41.	Edwin Stuewe	2	160	no
42.	E.A. Stuewe	11	320	no
43.	W.F. Schewe	10	240	no
44.	Lourine P. Miller	15,11,34,3	1,020	no
45.	Althea H. Strasen	14	240	no
46.	Lyle H. Heder	11,12,14	560	no
47.	A.H. & E.H. Strasen	12	80	no
48.	L.A. Langley	13,24	960	no
49.	Elmer Schutter	15,23	480	no
50.	L.G. Stuewe	22,23	400	no
51.	M. Buchli	24,23,26,25,30,31, 32,6,1,35	2,840	no
52.	M.J. Stuewe	27,26	560	no
53.	Davis-Noland-Merrill Grain Co.	29,28,27,34,33,32, 6,5,4,9,8,7	5,520	no
54.	L.C. Swanke	27,26	320	no
55.	W.E. Redemske	35,36	280	no
56.	Charles A. Redemske	36	440	no
57.	Clarence Miller	34	320	no
58.	Grace Lockhart	5,6,7,12,18,13,14, 15,16,19	5,460	yes
59.	Robert Wagstaff	35,2,1,11,10,9,17,16	4,340	yes
60.	Harriet K. Young	7	320	no
61.	R.J. & E. Smith	8	80	no
62.	P.T. Steeve	8	240	no
63.	M. Clark	8	160	no
64.	E. Falter	8	160	no
65.	Pine Grove Ranch	13	120	yes
66.	Virginia M. Zimmerman	13	240	no
67.	A. Umruh	13	120	no
68.	D.R. Holman	13	160	no
69.	W.J. Olsen	12,20	800	no
70.	Charles W. Olsen	12	160	no
71.	A.P. Grensing	1	560	no
72.	Augusta G. Dixon	36,31	880	no
73.	John W. Burr	30,31,29,32	1,600	no

	Owner	Section	Acres	Severence
74.	Keen Umbehr	18,13,7	690	no
75.	Charles Fink	18,13	380	no
76.	E.H. Brinkman	1,6,7	1,160	no
77.	A. Egert	6	200	no
78.	Lee Palenske	31	240	no
79.	W. Diehl	31	280	no
80.	F. Fink	30,31,36	200	yes
81.	A.H. Dieball	29,30	20	yes
82.	C. Wertzberger	30	20	yes
83.	Lydia Diepenbrock	30	180	yes
84.	D.H. Simon	36	140	yes
85.	H.W. Simon	1,2	360	yes
86.	Esther Thierer	1,2,14,23,33	620	no
87.	Lowell G. Thierer	2,11	400	yes
88.	Julia Munzer	14,13,12,11	1,500	no
89.	G. Thowe	18	120	no
90.	Charles Fink	18,13	290	no
91.	Marguerite Fink	11	400	no
92.	August Fink	24	160	no
93.	A.C. Fink	24	120	no
94.	A. Fink	24	320	no
95.	M. & F.W. Durein	24,25,15,29	840	no
96.	H. Grensing	25,26	640	no
97.	Jim Alfred Umbehr	23	160	no
98.	G. Grensing	22,23,26	540	no
99.	V.E. Claussen	2,3,10	480	no
100.	W.W. Schultz	10,39,20,21,27	1,270	yes
101.	A.G. Schultz	10,15,16	280	no
102.	A.G. & S. Schultz	21,22,27	670	no
103.	Kieth Elwood Schultz	10,21,34	370	no
104.	Lily O. Schultz	15,16,9,17	440	yes
105.	Wm. W. & Mary E. Schultz	28	640	no
106.	Guy McDiffett	9	70	no
107.	Rose H. Schultz	30,29,20	880	no
108.	F.W. Fink	22	150	no
109.	Sophie Schultz	21,22,27,26	560	no
110.	Willis A. Schultz	35	60	no
111.	Cleo A. Schultz	35	160	no
112.	Herbert E. Rogers	16	440	no
113.	T.O. Alley	17,20	340	yes
114.	M. & R. Rogers	20	50	yes
115.	L.O. Falk	19	280	yes
116.	R. Houtz	30,25,24	460	yes
117.	G.I. Newcomb	25,36	60	no

	Owner	Section	Acres	Severence
118.	R.E. Rogers	19	60	no
119.	A. & E. Zimmerman	19	220	no
120.	Kenneth Clough	36,14	450	no
121.	A.H. Langvardt	25,36	390	no
122.	C.W. Langvardt	36,1	380	no
123.	Joseph J. Cochrane	1	180	no
124.	Pauline L. Edwards	31	320	no
125.	H.R. Falk	31,32	640	no
126.	Howard R. Peterson	6	400	no
127.	Anna M. Martin	6	160	no
128.	Kermit J. Swanson	6	80	no
129.	B.R. Morris & C.J. Andrews	5	320	no
130.	M. Thompson	32	320	no
131.	John W. Burr	5	320	no
132.	Iva M. Thompson & Wilma C. McLaughlin	4	320	no
133.	A.W. Meinhardt	4	160	no
134.	V.L. Falter	33	160	no
135.	W.H. Fink	33	160	no
136.	J. Falter	33	160	no
137.	Helen Schrader	33	80	no
138.	G.H. Havenstein	34	160	no
139.	W. McLaughlin	34	320	no
140.	Wm. J. Olsen	35	160	no
141.	Virgie M. Kaul	35	160	no
142.	Penny & Elizabeth Clark	3	160	no
143.	N.B. Cornwell	3	160	no
144.	Harold Steere	3	160	no
145.	Lorin Bowman	3,10	320	no
146.	Mary Kathryn Thowe	2	320	no
147.	L.B. Johnson	2	160	no
148.	H. Peterson	2	160	no
149.	Lester C. Falter	10	300	no
150.	M.I. & C. Eberle	10	180	no
151.	L.E. Andres	11	160	no
152.	Jess A. Stagg	11	160	no
153.	Ivor L. Kahle	11	80	no
154.	Frank Meier, Jr.	11	240	no
155.	M.W. Converse	23,24	1,280	no
156.	A.A. Schultz	22	640	no
157.	Robert O. Schrader	21	320	no
158.	H.J. & E.C. Roulf	21	160	no
159.	James Woodbury	21	160	no
160.	C.E. & A.E. Florence	20	160	no
161.	Paul D. Wallis	20	160	no

B: LANDOWNERSHIP SUMMARY

Wabaunsee Study Area
May 5, 1975

I.	**TYPES OF OWNERSHIP**	(Acres)
	Federal	
	State	
	County	
	Township or town	
	City or village	
	Organization	
	Private	80,341
	Other	
	TOTAL ACRES	80,341
II.	**TYPES OF PRIVATELY OWNED IMPROVEMENTS**	(Number)
	Residential	
	Farm units	69
	Year-round residences	8
	Seasonal cottages	
	Other	
	Commercial	
	Motels and lodges	
	Service stations	
	Stores	
	Other – campground and museum	1
	Industrial	
	Organizational	
	Spec. Purpose Structures	
	TOTAL NUMBER IMPROVEMENTS	78
	TOTAL NUMBER LANDOWNERS	167
	TOTAL NUMBER TRACTS	167
	TOTAL NUMBER PEOPLE	312

C: ESTIMATED LAND ACQUISITION COST

Wabaunsee Study Area
May 5, 1975

LANDS	ACRES	ESTIMATED FAIR MARKET VALUE ($)	
Cropland	7,723	6,010,920	
Pasture	63,405	26,730,712	
Timberland	9,213	2,688,978	
Rec. Homesite			
Rec. Support			
Subtotal	**80,341**		**35,430,610**
Residential			
Commercial			
Rec. Homesite			
Subtotal			
Mineral – Included in land values above except for Davis Ranch Oil Field.			1,297,190
Easement			
IMPROVEMENTS	**NUMBER**		
Farm Units	69	2,685,183	
Residences			
Year-round	8	259,438	
Seasonal			
Comm. Buildings	1	77,832	
Subtotal			**3,022,453**
TOTAL LANDS AND IMPROVEMENTS			**39,750,253**
ADMINISTRATIVE AND TECHNICAL COSTS			**3,692,646**
REAL PROPERTY ACQUISITION ACT OF 1970			**1,010,000**
TOTAL ESTIMATED LAND ACQUISITION COST			**44,453,000**

Note: Land Cost Estimate is based on the assumption that authorization and appropriation of funds will be received within 2 years.

D: SUGGESTED PLANNING LEVEL FOR LAND ACQUISITION

Wabaunsee Study Area
(First 3 years)

First Year	$10,986,000
Second Year	$18,737,000
Third Year	$14,730,000

E: RELOCATION ASSISTANCE PAYMENTS UNDER PUBLIC LAW 91-646

Wabaunsee Study Area

In estimating the total cost for this project, the passage of Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, which was approved January 2, 1971, required the inclusion of an additional sum of $1,010,000 to pay for the moving and related expenses authorized under the act. This total figure was computed as follows:

Within the project boundaries there are 167 properties, the acquisition of which will displace 312 people. Of the 167 properties,

8 are classified as owner-occupied dwellings
69 are classified as owner-occupied farms
1 is classified as an owner-occupied business
89 are classified as unimproved, owned lands

SUMMARY

			167 Owners		
Total for each person displaced from owner-occupied dwelling unit	$ 4,000	X	8 unit(s)	$	32,000
Total for each person displaced from tenant-occupied dwelling unit	$	X	unit(s)	$	
Total for each owner of tenant-occupied dwelling unit	$	X	unit(s)	$	
Total for each displaced person from owner-occupied farm unit	$10,000	X	69 unit(s)	$	690,000
Total for each person displaced from tenant-occupied farm unit	$	X	unit(s)	$	
Total for each owner displaced from tenant-occupied farm unit	$	X	unit(s)	$	
Total for each person displaced from owner-occupied business unit	$10,000	X	1 unit(s)	$	10,000
Total for each person displaced from tenant-occupied business unit	$	X	unit(s)	$	
Total for each owner of tenant-occupied business unit	$	X	unit(s)	$	
Total for each person displaced from improved-owned land unit	$	X	unit(s)	$	
Total for each person displaced from improved-tenanted land unit	$	X	unit(s)	$	
Total for each owner of improved-tenanted land unit	$	X	unit(s)	$	
Total for each owner of unimproved land unit	$ 500	X	89 unit(s)	$	44,500

Total for each displaced person from special ownership				
$	X	unit(s)	$	
			Total	$ 776,500
			(Rounded)	$ 776,500
Administrative expense, relocation assistance, and contingencies (30%)				$ 232,950
			Total	$1,009,450
			(Rounded)	$1,010,000

ENCLOSURE 2: CHASE STUDY AREA

A. Landownership

B. Landownership Summary

C. Estimated Land Acquisition Cost

D. Suggested Planning Level for Land Acquisition

E. Relocation Assistance Payments Under Public Law 91-646

A: LANDOWNERSHIP

Chase Study Area

Owner	Township & Range	Section	Estimated Acres	Estimated Severence
Grace V. Hall	22R9	3,4,9	1,400	
J.W. Hughes	22R9	3	60	
4th National Bank	22R9	5,6,7,8,17	1,800	
J.M. Hughes	22R9	9,10,16,15	2,200	
J.E. Evans	22R9	14,13	800	160
Ed & Bertha Huber	22R9	17,27,28,34	2,080	
	22R8	13	160	
Neva North Myser	22R9	18	300	
N.W. Myser	22R9	18	20	
J.W. Myser	22R9	18,24,19	320	
Leonard L. Koehn	22R9	18	160	
	22R8	13	160	
Smith & Griffiths	22R8	11	120	40
H. Riddel	22R8	11	160	
H. Riedel	22R8	11	100	20
R.L. Riedel	22R8	10	60	400
V.J. Marcott	22R8	10	20	140
R.B. Vestring	21R9	2,3,10,11,15,22, 26,27,35	4,000	1,500
Josephine & Donald DeLong	21R9	16	640	
Marg C. Fees	21R9	14	320	
Elizabeth Ruth Owen	21R9	14	160	
E.R. Dietrich	21R9	14	160	
Maude Rapp	21R9	21	320	
Elizabeth J. Eno	21R9	23,24	640	160
1st National Bank	T21R9	20,21,28,27, 32,33,34	3,200	400
1st National Bank	T22R9	5	320	
E.N. Meyer	T21R9	29	400	80
George F. Allen	T21R9	31	480	160
George F. Allen	T21R8	36	60	100
George F. Allen	T22R8	1	560	80
Ropperman, M. Evans & M. Jones	T21R9	34	320	
Ropperman, M. Evans & M. Jones	T22R9	3,2,11,12,14,23	1,940	320+

Owner	Township & Range	Section	Estimated Acres	Estimated Severence
Marion Evans, et al	T22R9	12	160	
Gwendolyn Zitler Brown & Williams	T22R8	15,14,13,2,3	2,100	
G.L. Brandley	T22R8	16	500	140
E.E. Underwood	T22R8	17	40	200
Edith Bennett, et al	T22R8	17	10	80
H.H. Swift	T22R8	20,29,21	540	30
H.M. Crocker	T22R8	20,21,22	920	
W.M. Shaw	T22R8	22,27	440	
J. Underwood	T22R8	22	160	
F.J. Shaw	T22R8	22	160	
D.M. & Opal Bailey	T22R9	31	160	
Angie McDowell Wagy, et al	T22R8	25	320	
Wagy, Willett & Quiring	T22R9	30,31,32	1,120	
G.G. Merriman & 1st National Bank	T22R9	29,32	1,120	
R.M., R.A., & W.A. Barbe	T22R9	33	640	
Dail D. Martin	T22R9	34	160	
Vannocker	T22R9	34,35,26	960	
Mattie Shambaugh & Leota Roby	T22R9	26	160	?
Emma Eastman	T22R9	30	160	
James Bell, Jr.	T22R8	24,25	480	
M.M. Seguin	T22R8	26	480	
E. Seeney	T22R8	26	80	
L.N. Phipps	T22R8	27,28,34	320	
E.D. Skirvin	T22R8	28	160	
Cities Service Co.	T22R8	28,29	80	
H.H. & R.M. Talkington	T22R8	28	320	
C.S. Lips	T22R8	30	160	
C.B. Romeiser	T22R9	19	80	
Emma Eastman	T22R9	19,30	320	
Harold F. Jones	T22R9	19,20	480	
Adaline & James Beedle	T22R9	20	160	
Nellie Hughes Underwood	T22R9	20,21,22	1,600	
S. Somers Enterprises	T22R8	32,33,34	960	
	T23R8	4	320	
O. & C. Dohner	T23R8	5	320	
Crocker	T23R8	5	320	
Opal Lewis	T22R8	31	160	?

Owner	Township & Range	Section	Estimated Acres	Estimated Severence
Hilah Crocker	T22R8	32	320	
Laird K. Crocker	T22R8	30,31	320	
Clella Dohner	T22R8	32	320	
Hazel D. North	T22R8	33	320	
J. Samples, Jr.	T22R8	34	120	
Hazel K. & Robert M. Brown	T22R8	34,35	680	
G. Lewis	T22R8	36	640	
	T23R8	1	320	
Letha L. Coleman	T23R9	9,16	800	
Sarah M. Rhodes, et al	T23R9	7,8,17,18,19,20, 21	3,840	
E.R. Sheets	T23R8	13	160	
D.W. Evans	T23R8	2,3,4,8,9,10,11, 12,13,14,15	5,120	
J.C. Gallagher	T23R8	8	160	
E.S. Breen	T23R8	8,7	160	320
T.D. Lisman	T23R8	1,11,12	880	
	T23R9	7	320	
George C. Noller, et al	T23R9	3,4,10	1,280	320
C.C. Bledsoe	T23R9	5,6	1,280	
Gomer Lewis	T23R8	1	320	
	T22R8	27	400	
Hazel & Robert Brown	T23R8	2	400	
Martha E. Barrier	T23R8	33	320	
K.H. Harsh	T23R8	33	320	
C.L. & R.A. Berthulf	T23R8	32	320	
Dorothy D. Janney	T23R8	27		
	T23R9	30,29	1,600	
L.E. Watkins	T23R8	28	10	320
E. Gandner & P.F. Dales	T23R8	25,26	320	
G.E. & R.R. Jackson	T23R8	25	160	
Mabel M. Wonder	T23R8	25,24	720	
James M. Teter	T23R9	21,22,23,14,15	320	1,850
Charles E. & Daniel Wells	T23R8	24	240	
R.R. Harsh	T24R8	4,5	480	
R. Neal & P.L. Harsh	T24R8	4	80	
H. Harsh	T24R8	4	320	
F.E. Wichers	T24R8	4	80	
N.M. Harsh	T24R8	5	200	

Owner	Township & Range	Section	Estimated Acres	Estimated Severence
R.N. Harsh	T24R8	5	120	
Ruth Teter	T23R9	34	80	320
Murle Teter	T23R9	34,27	240	
Sara Rhue	T23R9	32	40	
K. Mitchell	T23R9	32	20	
Title Trust & Guarantee Company	T23R9	32	100	
Robert A. Zebold	T23R9	31		
	T23R8	23,34,35,27,26	2,600	
Paul Scott, et al	T23R9	31	160	
C.R. Nuttle	T24R8	19,20,30,27,29, 28,31,32,33,34	1,610	3,520
David Thompson, et al	T24R8	28,32	240	
Elvin Winn	T24R8	28	40	
H.S., H.M. & John F. Winn	T24R8	28	480	
George E. Lewis	T24R8	27	320	
George & Karl Jackson	T24R8	27,26,34,35	810	800
C. Robert Buford	T24R8	22,23,24,25	1,920	640
	T23R8	6	320	?
John Henley	T24R8	9,21	320	
James A. Henley, et al	T24R8	20,21,16,17,18, 7,8,9	3,200	960
C.H. Dater	T24R8	11,14,13	880	
S.E. Robbins	T24R8	14	320	
Shirley M. Rawnsley	T24R8,R9	13,15,16	800	165
Edward H. Hawthorne	T24R9	7,8,17,18	1,920	
Ella M. Bilson	T24R9	17,18,19,20, 29,32	480	
Dora Mae Hagerman	T24R9	16	80	
Dalebanks Angus, Inc.	T24R9	16,21	160	160
Tom Henderson	T24R9	9	640	
Mary Klasser	T24R8	1,2,11,12,10	2,480	
	T23R8	36	640	
Lyman Henley	T24R8	10	80	
John Henley, et al	T24R8	9,21	320	
James A. Henley	T24R8	21,20,16,17,18, 9,8,7	3,200	960
Norbert A. Zebold, Jr.	T24R8	10,3	640	
Christine Christy	T24R9	2,3,4,10	1,280	700
Helen T. Zebold	T24R9	5,6		
	T23R9	31,32,33,34, 28,27		
	T23R8	16,17,20	4,880	400

B: LANDOWNERSHIP SUMMARY

Chase Study Area
May 6, 1975

I.	TYPES OF OWNERSHIP	(Acres)
	Federal	
	State	
	County	
	Township or town	
	City or village	
	Organization	
	Private	102,833
	Other	
	TOTAL ACRES	102,833
II.	TYPES OF PRIVATELY OWNED IMPROVEMENTS	(Number)
	Residential	
	Farm units	16
	Year-round residences	12
	Seasonal cottages	
	Other	
	Commercial	
	Motels and lodges	
	Service stations	
	Stores	
	Other	
	Industrial	
	Organizational	
	Spec. Purpose Structures	
	TOTAL NUMBER IMPROVEMENTS	28
	TOTAL NUMBER LANDOWNERS	126
	TOTAL NUMBER TRACTS	126
	TOTAL NUMBER PEOPLE	140

C: ESTIMATED LAND ACQUISITION COST

Chase Study Area
May 6, 1975

LANDS	ACRES	ESTIMATED FAIR MARKET VALUE ($)	
Cropland	1,316	861,560	
Pasture	99,220	38,974,466	
Timberland	2,297	602,306	
Rec. Homesite			
Rec. Support			
Subtotal	**102,833**		**40,438,332**
Residential			
Commercial			
Rec. Homesite			
Subtotal			

Mineral — Included in land prices above.

Easement

IMPROVEMENTS	NUMBER		
Farm Units	16	523,745	
Residences			
Year-round			
Seasonal	12	282,822	
Comm. Buildings			
Subtotal			**806,567**

TOTAL LANDS AND IMPROVEMENTS	**41,244,900**
ADMINISTRATIVE AND TECHNICAL COSTS	**3,831,500**
REAL PROPERTY ACQUISITION ACT OF 1970	**336,500**
TOTAL ESTIMATED LAND ACQUISITION COST	**45,413,000**

Note: Land Cost Estimate is based on the assumption that authorization and appropriation of funds will be received within 2 years.

D: SUGGESTED PLANNING LEVEL FOR LAND ACQUISITION

Chase Study Area
(First 3 years)

First Year	$13,500,000
Second Year	$16,550,000
Third Year	$15,363,000

E: RELOCATION ASSISTANCE PAYMENTS UNDER PUBLIC LAW 91-646

Chase Study Area

In estimating the total cost for this project, the passage of Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, which was approved January 2, 1971, required the inclusion of an additional sum of $336,500 to pay for the moving and related expenses authorized under the act. This total figure was computed as follows:

Within the project boundaries there are 126 properties, the acquisition of which will displace 140 people. Of the 126 properties,

6	are classified as owner-occupied dwellings
6	are classified as tenant-occupied dwellings
16	are classified as owner-occupied farms
98	are classified as unimproved, owned lands

SUMMARY

Total for each person displaced from owner-occupied dwelling unit	$ 4,000	X	6 unit(s)	$ 24,000
Total for each person displaced from tenant-occupied dwelling unit	$ 4,000	X	6 unit(s)	$ 24,000
Total for each owner of tenant-occupied dwelling unit	$ 300	X	6 unit(s)	$ 1,800
Total for each displaced person from owner-occupied farm unit	$10,000	X	16 unit(s)	$160,000
Total for each person displaced from tenant-occupied farm unit	$	X	unit(s)	$
Total for each owner displaced from tenant-occupied farm unit	$	X	unit(s)	$
Total for each person displaced from owner-occupied business unit	$	X	unit(s)	$
Total for each person displaced from tenant-occupied business unit	$	X	unit(s)	$
Total for each owner or tenant-occupied business unit	$	X	unit(s)	$
Total for each person displaced from improved-owned land unit	$	X	unit(s)	$
Total for each person displaced from improved-tenanted land unit	$	X	unit(s)	$
Total for each owner of improved-tenanted land unit	$	X	unit(s)	$
Total for each owner of unimproved land unit	$ 500	X	98 unit(s)	$ 49,000

Total for each displaced person from special ownership	$	X	unit(s)	$
			Total	**$258,800**
			(Rounded)	**$258,800**
Administrative expense, relocation assistance, and contingencies (30%)				$ 77,640
			Total	**$336,440**
			(Rounded)	**$336,500**

ENCLOSURE 3: OSAGE STUDY AREA

A. Landownership

B. Landownership Summary

C. Estimated Land Acquisition Cost

D. Suggested Planning Level for Land Acquisition

E. Relocation Assistance Payments Under Public Law 91-646

A: LANDOWNERSHIP

Osage Study Area

	Owner	Section	Acres	Severence
1.	Kermit G. Murphy	24	140	yes
2.	M.L. Jones	2	110	yes (small)
3.	Frank Travis	2	40	yes
4.	V. Wineinger	2	40	yes
5.	J.M. Holroyd	3,11	100	no
6.	N.H. Fesler	3,4,9,10	280	no
7.	Lyman Fesler	4	80	no
8.	Winajean Williamson	4	200	no
9.	E. & D. Lemert	4,7,8,13,18,17, 16	2,590	yes
10.	Vaughn Rygar	33	40	yes (large)
11.	Marie Kennedy	5	320	yes
12.	Floyd K. & R.O. Mills	5	300	yes (small)
13.	Dale & Fern Seaman	6	400	no
14.	Cecil A. Ridgeway	6,31,1	230	no
15.	Catharine House	1,12,7	1,480	no
16.	O.S. Cable	1	60	no
17.	C.H. House	36	80	yes
18.	Arch G. Gothard	13,10,11,15,14, 13	2,160	no
19.	Clarence Merz	13,11	360	yes
20.	Donald W. Dale	3,4	480	no
21.	J.G. Kelley	3,4,9,10	320	no
22.	Pauline Johnson			
23.	O.D. Sartin	4,5,9	360	yes (small)
24.	L.M. Day	4,9	120	no
25.	M.H. Johnson	5,6	200	yes
26.	J.E. Shelton	7,18,17	1,390	no
27.	N. Ramsey	6,7,18	380	yes
28.	O.W. Olsen	7	350	no
29.	R.E. Shelton	8	160	no
30.	F. Montgomery	8,9	360	no
31.	C. Koonce	8	80	no
32.	L.G. Magnus	8,17,16	560	no
33.	K.S. Adams	(KS)17,16,15,14,13, (OK)18,17,16,15,14, 13,20,21,22,23,24, 28,27,26,25,34,35, 36,2,1,11,12,14, 13,22,23,24,27, 26,25,34,36	15,120	yes

	Owner	Section	Acres	Severence
34.	F.A. Drummond	16	120	no
35.	C.O. Clapp, Jr.	9	200	no
36.	Alta Rich	10	40	no
37.	Lee & Dee Lemert	8,9,17,16	880	no
38.	R.D. Wilkinson	8,9	120	no
39.	Lois Husar	16	90	no
40.	Thurmon Holroyd	16,15,10,11	590	no
41.	T.L. & J. Holroyd	10,9,15	280	no
42.	Aldine M. Carter	10,15	240	no
43.	Sylvia Pope	15	160	no
44.	J.M. Holroyd	11	80	no
45.	Howard H. Layton	14,15	640	no
46.	Frank Travis	11	240	yes
47.	Lyla Winchell	14	80	yes
48.	Mary L. Anderson, Jody L. & M.D. Richardson	13,14,23,22,21, 28,27,33,34	2,000	no
49.	R. Kelsey	23	5	no
50.	J.A. Chapman	(East)13,24,23,27,26, 25,34,35,36,1,2,3, 10,11,12,15,14,13, 18,19,20,30 (West)19,20,21,30, 29,28,35,36,31, 32,33,6	15,000	yes
51.	Emma Maker	13	160	no
52.	Frances Bascus	14	120	no
53.	D.E. Stine	15,22,16,21, 17,20,18,19	2,700	no
54.	Thelma Bangs	16,21,25,26	320	no
55.	Mary C. Hopper	16	140	no
56.	Wm. S. Fletcher	17	120	no
57.	Omer L. Jefferson, Jr.	18	80	no
58.	Vernon Butler	13	120	no
59.	Julia C. Lookout Red Eagle	15,16	360	yes
60.	Stephanie Kensworthy	15,16	320	yes
61.	Marie L. Morrell & Kay B. McCurtain	15,22	160	no
62.	Arch G. Gothard & Fred A. Drummond	16,21	320	no
63.	Dorothy Pack	21,28	160	no
64.	Betty J. Hudson & Mary J. Hudson	19,20,30,29, 31,32,33	2,920	no

	Owner	Section	Acres	Severence
65.	Grace Mashunkashey, Hudson & Hudson	20	(Pt. of Sec. 20 above)	
66.	Pauline & Charles Hutchinson	21,28	320	no
67.	Mary Osage Green	25,20	640	no
68.	Mitchell L. Hutchinson	36	320	yes
69.	C.E. Norton James E. Norton Adelaide M. Moore		160	no
70.	Lincoln F. Robinson	33,34,7,9, 18,16,15	1,440	no
71.	Elizabeth Stangl	32,9,10,16, 17	1,000	no
72.	James B. Robinson	7,8,18,17	1,000	no
73.	Margaret F. Robinson	5,4,3,10	1,190	no
74.	Shelley D. Iron	32	160	no
75.	May B. Robinson	31,6,5,8,9, 17,18	1,520	no
76.	Olivia, Nancy, Freda, & George Gilliland	31	40	no
77.	Franklin Brave	27,1	240	no
78.	Billie A. Steen	1	160	no
79.	Cecilia Tallchief	5,4	320	no
80.	Harold West	5,6,24,25	480	no
81.	Howard West, Jr.	6	240	no
82.	Helen M. Bear	6	160	no
83.	Emma H. Hope	1,2	320	no
84.	Emma Haynie	1	80	no
85.	Martha Jones Gross	12	160	no
86.	Hazel F. Daniels	9,22,27	480	no
87.	Omer L. Jefferson	7	80	no
88.	Myrtle Fletcher Katherine Hopper Laura Shannon	7,18	160	no
89.	Charles A. Stuart	12	160	no
90.	Alfred A. Pryor	11	120	no
91.	Josephine West	11	160	no
92.	Omer C. Tallchief	17	160	no
93.	Oklahoma Land & Cattle & Frederick L. Red Eagle	27	160	no
94.	Fannie Potts	14	160	no
95.	Elizabeth Ann Robinson	15	160	no
96.	Josephine Tillman	17	160	no
97.	Marilyn H. Wann	Sec. 14—joint with Adams		

	Owner	Section	Acres	Severence
98.	D.L. Haskell Nora C. Stuart	14	160	no
99.	Ellen Mae Hickey	14	160	no
100.	Elizabeth Roberson	29	160	yes
101.	H.G. Barnard	24,23,22,27, 26,25,36,35,34, 35,6,5,4,3,2,1, 6,31,30,32,5,8,7, 12,11,10,9,8,16, 15,14,13,18,17, 19,24,23,22,26, 25,30,29,32,31, 36	18,910	yes
102.	Eva Kensworthy	23	320	no
103.	Ellen M. Thomison	23,24	100	no
104.	Drummond & Barnard	26	160	no
105.	H.H. Barnard	27	160	no
106.	Lena Brave & Mary Revard	27	160	no
107.	Lohman Brothers	26	25	no
108.	C.E. Norton James E. Norton Adelaide M. Moore	36	160	no
109.	Wm. Bigheart, Jr.	33	320	no
110.	Oklahoma Department of Wildlife Conservation	34	160	no
111.	Charles R. Gray Theodore C. Murray	1	160	no
112.	Louis Pah Se To Pah	12,11,12	640	no
113.	Frank C. Gibbs	6	160	no
114.	Delores Strikeax	11	160	no
115.	Irene Woods	10	160	no
116.	Mildred L. Hutchinson	17,20	80	yes
117.	Charles F. Stuart	19,20	80	yes
118.	John Oglesby	23	160	no
119.	St. John & Barnard	36,30	160	no
120.	Pearson & Barnard	30	40	no
121.	Evelyn O. Pitts	31	120	no
122.	Carla J. Sellers	4,9,30,23, 14,15	560	no
123.	Christopher Pah Se To Pah	15	80	no

B: LANDOWNERSHIP SUMMARY

Osage Study Area
May 7, 1975

I.	TYPES OF OWNERSHIP	(Acres)
	Federal	
	State	
	County	
	Township or town	
	City or village	
	Organization	
	Private	97,902
	Other	
	TOTAL ACRES	97,902
II.	TYPES OF PRIVATELY OWNED IMPROVEMENTS	(Number)
	Residential	
	Farm units	23
	Year-round residences	
	Seasonal cottages	
	Other	
	Commercial	
	Motels and lodges	
	Service stations	
	Stores	
	Other	
	Industrial	
	Organizational	
	Spec. Purpose Structures	
	Large ranch headquarters	2
	TOTAL NUMBER IMPROVEMENTS	25
	TOTAL NUMBER LANDOWNERS	105
	TOTAL NUMBER TRACTS	105
	TOTAL NUMBER PEOPLE	125

C: ESTIMATED LAND ACQUISITION COST

Osage Study Area
May 7, 1975

LANDS	ACRES	ESTIMATED FAIR MARKET VALUE ($)	
Cropland	2,483	1,483,217	
Pasture	88,746	35,341,547	
Timberland	6,673	1,771,604	
Rec. Homesite			
Rec. Support			
Subtotal	**97,902**		**38,596,368**
Residential			
Commercial			
Rec. Homesite			
Subtotal			
Mineral			
Easement			
TOTAL LAND AREA	**97,902**		
IMPROVEMENTS	**NUMBER**		
Farm Units	23	763,279	
Residences			
Year-round			
Seasonal			
Comm. Buildings			
Large Ranch Headquarters	2	596,353	
Subtotal			**1,359,632**
TOTAL LANDS AND IMPROVEMENTS			**39,956,000**
ADMINISTRATIVE AND TECHNICAL COSTS			**3,711,760**
REAL PROPERTY ACQUISITION ACT OF 1970			**412,000**
TOTAL ESTIMATED LAND ACQUISITION COST			**44,080,000**

Note: Land Cost Estimate is based on the assumption that authorization and appropriation of funds will be received within 2 years.

D: SUGGESTED PLANNING LEVEL FOR LAND ACQUISITION

Osage Study Area
(First 3 Years)

First Year	$11,192,500
Second Year	$17,519,000
Third Year	$15,368,500

E: RELOCATION ASSISTANCE PAYMENTS UNDER PUBLIC LAW 91-646

Osage Study Area

In estimating the total cost for this project, the passage of Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, which was approved January 2, 1971, required the inclusion of an additional sum of $412,000 to pay for the moving and related expenses authorized under the act. This total figure was computed as follows:

Within the project boundaries there are 105 properties, the acquisition of which will displace 125 people. Of the 105 properties,

13 are classified as owner-occupied farms
10 are classified as tenant-occupied farms
80 are classified as unimproved, owned lands
2 are classified as large ranches

SUMMARY

Total for each person displaced from owner-occupied dwelling unit	$	X	unit(s)	$
Total for each person displaced from tenant-occupied dwelling unit	$	X	unit(s)	$
Total for each owner of tenant-occupied dwelling unit	$	X	unit(s)	$
Total for each displaced person from owner-occupied farm unit	$10,000	X	13 unit(s)	$130,000
Total for each person displaced from tenant-occupied farm unit	$10,000	X	10 unit(s)	$100,000
Total for each owner displaced from tenant-occupied farm unit	$ 300	X	10 unit(s)	$ 3,000
Total for each person displaced from owner-occupied business unit	$	X	unit(s)	$
Total for each person displaced from tenant-occupied business unit	$	X	unit(s)	$
Total for each owner of tenant-occupied business unit	$	X	unit(s)	$
Total for each person displaced from improved-owned land unit	$	X	unit(s)	$
Total for each person displaced from improved-tenanted land unit	$	X	unit(s)	$
Total for each owner of improved-tenanted land unit	$	X	unit(s)	$
Total for each owner of unimproved land unit	$ 500	X	80 unit(s)	$ 4,000

Total for each displaced person from special ownership (large ranches)	$40,000 X	2 unit(s)	$ 80,000
		Total	**$317,000**
		(Rounded)	**$317,000**
Administrative expense, relocation assistance, and contingencies (30%)			$ 95,100
		Total	**$412,100**
		(Rounded)	**$412,000**

K: OIL, GAS, AND MINERAL EVALUATION

ARCHAEOLOGICAL RESOURCES
(OUTLINE OF DOCUMENT THAT WILL BE PREPARED)
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
Denver Service Center
National Park Service
United States Department of the Interior

L: ARCHAEOLOGICAL RESOURCES
(OUTLINE OF DOCUMENT THAT WILL BE PREPARED)

SOCIAL SURVEY
ALTERNATIVE STUDY AREAS
PROPOSED PRAIRIE NATIONAL PARK
KANSAS/OKLAHOMA

Prepared by
Denver Service Center
National Park Service
United States Department of the Interior

SOCIAL SURVEY STUDY

A study to develop information associated with social patterns within and surrounding the alternative study areas is needed to complete this assessment. It will be necessary to collect both demographic and survey-related information in order to assess the relationships between existing social structures and adaptive strategies of the Flint Hills region, and alternative uses of the prairie. One set of alternatives is contained in this assessment: prairie preservation. It will be important to identify the critical alternatives affecting the uses of the prairie, and to assess the relationships between them and current adaptive strategies.

This study should address two scales of information. First, existing recreation patterns, economic patterns, living patterns, and attitudes toward future alternatives for the prairie should be identified within and around the three study areas. Sources of information should include existing demographic data, surveys, and workshops. Studies directly related to the study areas should assess relationships between adaptive patterns and future alternatives for the prairie in terms of compatibility.

A second scale of study should extend up to 50 miles from each study area to include large urban centers. This aspect of the study is intended to identify existing knowledge of and attitudes toward prairie alternatives.

The combination of site-specific and regional information is intended to identify the compatibility of future alternatives for the prairie (including National Park Service concepts for preservation) with expressed opinions and adaptive strategies within the Flint Hills.

OUTLINE OF ECONOMIC INPUT TO A PRAIRIE NATIONAL PARK ALTERNATIVE STUDY AREAS PROPOSED PRAIRIE NATIONAL PARK KANSAS/OKLAHOMA

Prepared by
Denver Service Center
National Park Service
United States Department of the Interior

OUTLINE OF ECONOMIC INPUT TO A PRAIRIE NATIONAL PARK

OBJECTIVES

National Park Service planning decisions in a Prairie National Park may have significant implications for four economic units. These units are the park visitor, the park community, the park region, and the National Park Service. The objective of this investigation is to describe the economic environments of these units and to analyze expected economic impacts from alternative National Park Service proposals.

PROCEDURES

The design of the study will be first to define each of the economic units more specifically, determine appropriate social indicators and economic variables, and list sources of data. Second, the description to the economic environment will be outlined. Third, a discussion of the economic impact analysis will be given. And fourth, areas for further study will be discussed.

I. DEFINITION OF ECONOMIC UNITS, DATA REQUIREMENTS, AND SOURCES

A. The Park Visitor

The park visitor economic unit is broadly defined to include anyone who may visit a Prairie National Park with a recreational motivation. There are obvious difficulties involved in projecting visitor numbers and characteristics for a new-area study. No data exist for a park not yet created, and a visitor-use study is impossible. These difficulties are amplified in the case of prairielands, since no nearby park unit possessing similar natural features is available for surrogate direction.

Hence, the analysis of the visitor economic units will be based upon forecasts and probabilities in an effort to overcome the uncertainties of prairielands visitation. Some of the visitor data needed are:

1. Number of visitors
2. Place of origin
3. Length of trip and route taken
4. Purpose of trips
5. Length of stay in prairielands
6. Means of conveyance
7. Overnight lodging

8. Places visited in prairielands
9. Expenditures
10. Values of recreational experience
11. Value functions with respect to crowding
12. Services needed
13. Recreational activities to be provided
14. Preferences for park development
15. Age
16. Sex
17. Education
18. Occupation
19. Income

Some data sources for this information will be Bureau of Outdoor Recreation documents, highway travel statistics, general National Park Service visitor studies, and various university studies.

B. The Park Community

The park community includes park concessionaires and their employees, employees of the National Park Service, and other people living in communities within and near the park boundaries. This will be an important section of the prairielands study. Prairie is quite unique among National Park Service new area units in that it will be created from non-public lands. This means that Park Service management controls must be obtained from private owners of the resources. Economic impacts upon current resource owners and communities will vary with the method chosen for obtaining management control. These alternatives must be described in detail, and the expected impacts of each must be carefully investigated.

Information needed to specify this section of the study includes the following from concessionaires, ranchers, and other businesses:

1. Investments and repairs
2. Payroll and wages
3. Interest
4. Goods purchased for resale
5. Taxes: sales, payroll, property, federal
6. Park lease fees
7. Gross receipts
8. Net receipts
9. Employment
10. Services provided
11. Agricultural production
12. Mining and mineral products

13. Power generation potential
14. Property values

C. The Park Region

The park region is defined as groups of counties around the three alternative Prairie National Park sites that may be significantly affected by alternative Park Service actions. The following data will come primarily from census sources. This is a general list that may be modified and elaborated upon in greater detail depending upon specific interests and data availability.

1. Income
    a. Median family income
    b. Personal income
    c. Total wages and salaries
    d. Other labor income
    e. Proprietors' income
    f. Property income
    g. Transfer payments
    h. Less social insurance contributions
    i. Total earnings
    j. Farm earnings (size of farms, type of farms)
    k. Total non-farm earnings
        (1) Government earnings
        (2) Total federal government
            (a) Federal civilian
            (b) Federal military
        (3) State and local government
        (4) Private non-farm
            (a) Manufacturing
            (b) Mining
            (c) Contract construction
            (d) Transportation, communications, and public utilities
            (e) Wholesale and retail trade
            (f) Financial, insurance, and real estate
            (g) Services
            (h) Other
2. Employment
    a. By major classification
        (1) Professional
        (2) Managers
        (3) Sales workers
        (4) Clerical
        (5) Craftsmen

(6) Operatives
(7) Transportation operatives
(8) Laborers
(9) Farmers
(10) Farm laborers
(11) Service workers
(12) Personal households

b. Unemployment levels

3. Population-demographic
   a. Population per square mile
   b. Population trends
   c. Age characteristics
   d. Sex characteristics
   e. Education
   f. Net migration
   g. Housing characteristics
   h. Health characteristics
4. Local government finances
   a. General revenue
      (1) Total taxes
      (2) Property taxes
      (3) State revenues
      (4) Federal revenues
   b. Important industrial sectors
   c. General expenditures
      (1) Total per capita
      (2) Education
      (3) Highways
      (4) Public welfare
      (5) Health and hospitals

D. The National Park Service

The National Park Service may be thought of here as an institutional economic unit. It has institutional objectives and budgetary constraints. Hence, it is important to assess the costs and benefits to the National Park Service as it proposes alternative actions in seeking its objectives.

1. Direct costs
   a. Land purchase
   b. Construction
   c. Removal of intrusions
   d. Purchase of capital equipment
   e. Development costs

f. Operation and maintenance
g. Resources management
h. Law enforcement
i. Fee collection
j. Interpretation

2. Direct benefits
   a. Number of visitors
   b. Visitor enjoyment and satisfaction
   c. Variety of activities provided
   d. Ecological preservation
   e. Fee collections
3. Indirect costs and benefits

II. ECONOMIC BASE ANALYSIS

The economic base analysis includes a detailed investigation of the economic environment. It is described in terms of the economic variables and indicators listed in the previous section. Not all of the information listed there will be included in the planning and environmental documents. However, it will be used as support data for the descriptive sections of those documents.

In the economic descriptions, exchanges over time will be studied through time-series analysis, and in some cases future projections will be estimated. Comparisons between relevant geographic units (for example, the prairielands region and appropriate states) will also make the data more meaningful.

III. ECONOMIC IMPACT ANALYSIS

The purpose of the impact analysis is to estimate the economic impact of alternative Park Service proposals on the relevant economic units (i.e., the park visitor, the park community, the park region, and the National Park Service). The variables described in section I of this paper will be used to evaluate the expected impacts.

The impact analysis will be carried out in two phases. First, a general inter-industry model will be specified to determine the important industrial sections in the area and their interrelationships.

Sectors that are relatively significant to the tourist and outdoor recreation industry will receive major detail and emphasis. Information gained from this model of the general economy will be used in the decision-making process of choosing relevant alternatives. Once these alternatives have been chosen, a second iteration of the model will follow. This is the second phase of the impact analysis. It will evaluate each of the alternatives and estimate their economic impacts upon the relevant economic units.

IV. OTHER ECONOMIC INPUTS

A. Carrying Capacity (visitor-use levels)

B. Resource Allocation (opportunity costs of non-recreational resource uses if a park unit is established)

C. Rationing Schemes (how resources are allocated to alternative visitor uses, and among all potential visitors)

D. Alternative Methods of Gaining National Park Service Management Control

1. Fee ownership
2. Purchase of easements
3. Fee ownerships, granting easements to current owners
4. Other

E. Alternative Sites

1. Economic criteria for choosing among sites
2. Economic criteria for choosing the geographic size of an impacted region

ARCHAEOLOGICAL RESOURCES STUDY

In order to complete this assessment, the following study should be conducted for archaeological resources:

A. Inventory of Archaeologic Resources

1. A brief discussion from the literature of prehistoric cultural traditions represented within the Flint Hills region of Kansas and Oklahoma as a setting for the three sites. This review should encompass cultural traditions from prehistoric up to historic times with a summary of the cultural patterns and forms associated with the various adaptive strategies, i.e., nomadic hunters, hunter-gatherers, agriculturalists, etc. Any mapping that would be helpful in understanding these patterns should be provided.

2. An inventory and mapping of known sites within or immediately surrounding the three study areas from existing sources.

3. Predict levels of probability of archaeologic site density and type, and map based on the following suggested criteria:

   a. Prehistoric occupation zones within the region.

   b. Prehistoric cultural traditions and subcultures.

   c. Identification of zones or units expected to have similar site densities or types of sites based on available resources, i.e., water, vegetation, physiography, etc.

   d. A sampling procedure sensitive enough to be useful in determining possible differences between sites, yet simple enough to be applied to the study areas within the time frame.

B. Analysis of Artifacts

1. Identify any sites or areas that are unique or representative of a particular culture either common or uncommon to the region.

2. Identify any sites or areas that represent continuous occupations over time.

C. Mapping Requirements

Mapping will be accomplished at 1:24,000 scale, 7½ minute series, which was used to prepare the study area base maps. The government will furnish a set of study area base maps, and additional copies and/or reproducibles are available. Base maps of natural resources will be provided.

M: OUTLINE OF ECONOMIC INPUT TO A PRAIRIE NATIONAL PARK

N: SOCIAL SURVEY

Publication services were provided by the graphics and editorial staffs of the Denver Service Center. NPS 553

☆U.S. GOVERNMENT PRINTING OFFICE: 1975—677-346/26