WICHITA STATE UNIVERSITY

# Ninnescah Research Station and Natural History Reservation

Multidisciplinary Field Trip

GUIDEBOOK

9 October 1988

KANSAS ACADEMY OF SCIENCE
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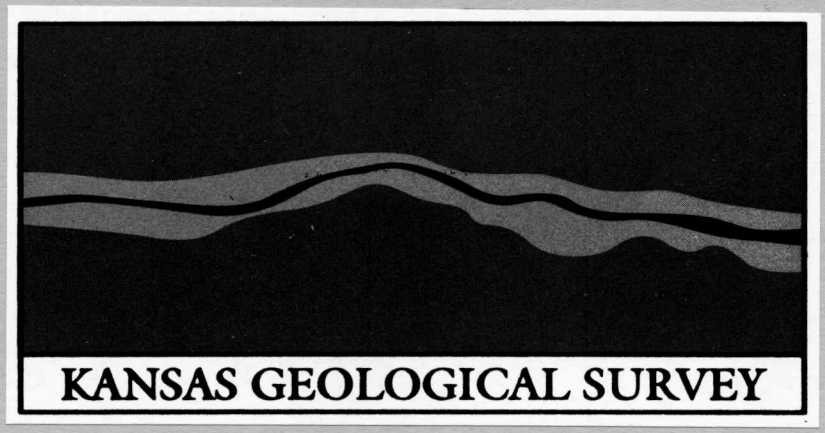
KANSAS GEOLOGICAL SURVEY

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## OPEN-FILE REPORT 88-33

WICHITA STATE UNIVERSITY
Ninnescah Research Station and Natural History Reservation

prepared by the

Kansas Academy of Science

Multidisciplinary Field Trip Guidebook
9 October 1988



KANSAS GEOLOGICAL SURVEY
1930 Constant Avenue
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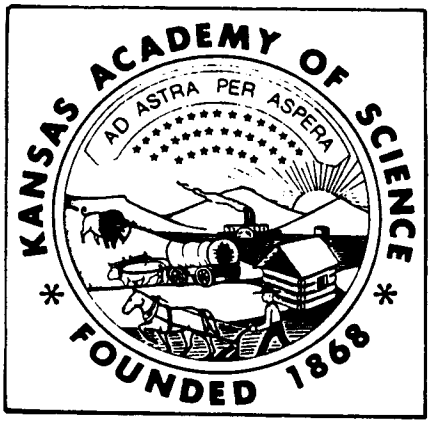
WICHITA STATE UNIVERSITY

Ninnescah Research Station and Natural History Reservation




KANSAS ACADEMY OF SCIENCE

Multidisciplinary Field Trip

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CONTENTS

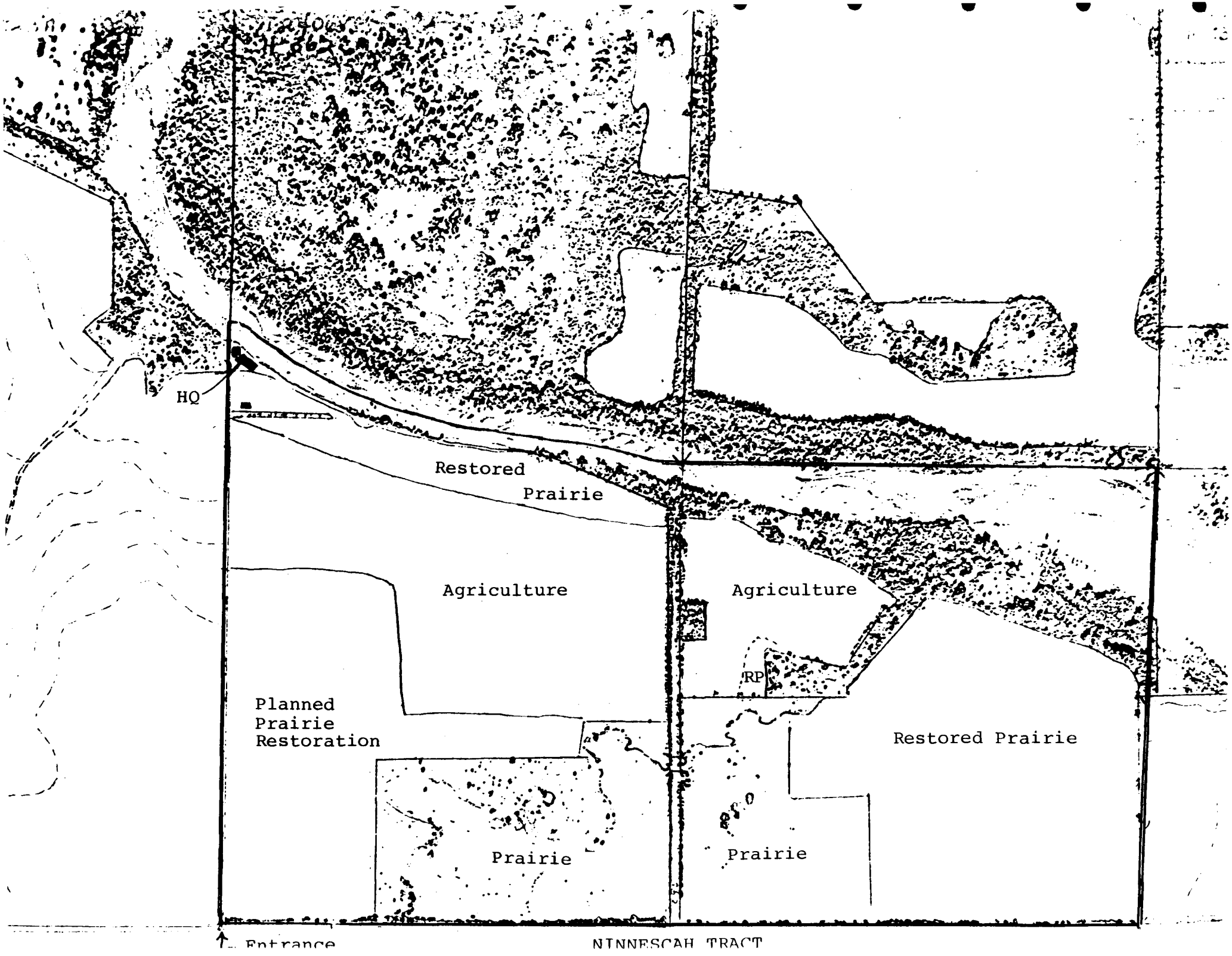
This field excursion is the first of what is hoped will be a series of field experiences to the Natural Areas of Kansas. It is the logical follow up on the Symposium on Natural Areas of Kansas which was held at the April 1987 annual meeting of the Kansas Academy of Science in Wichita (see Kansas Academy of Science Transactions, v. 91, nos. 1-2, 1988, 62 p.).

The idea of a multidisciplinary field trip has been suggested for a long time, however it is difficult to schedule. With the theme of Natural Areas of Kansas, it is easier to arrange. Each year a different area in the State can be visited to learn first-hand of the differences and similarities of the plethora of physiographic, geologic, ecologic, ect. areas within its 82,264 square miles. The possibility to visit each of these areas under the tutelage of experts should be exciting, interesting, and rewarding.

For this first multidisciplinary trip we have arranged to have as leaders a prairie biologist, geologist, limnologist, aquatic biologist, archeologist, and ornithologist. By walking through the Ninnescah Tract with these experts, it will be possible to satisfy your curiosity and answer questions you have always wanted to know about nature and natural conditions. In this very brief guide you will find descriptions of the prairie grasses and woodlands, water, geology, soils, limnology, amphibians, reptiles, birds, mammals, fish, insects, and the archeology.

We hope you will benefit from this field experience and take great pleasure in welcoming you to the Wichita State University's Ninnescah Research Station and Natural History Reservation.

D.F. Merriam
KAS President-Elect


HQ
Restored
Prairie
Agriculture
Agriculture
RP
Planned
Prairie
Restoration
Restored Prairie
Prairie
Prairie
Entrance
NINNESCAH TRACT

# INTRODUCTION TO THE

# WICHITA STATE UNIVERSITY NATURAL AREA

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In 1983 The Wichita State University Endowment Association acquired 330 acres south and adjacent to a 1 mile stretch of the Ninnescah River in southwestern Sedgwick County. The area is located principally in the SE of sec. 7 and SW of sec. 8, T29S, R3W. At the time of acquisition, much of the Ninnescah Tract (Research Station and Natural History Reservation) was under cultivation to wheat and milo and occasionally alfalfa and oats. In addition to the agricultural land, the Ninnescah Tract consists of two original prairie segments of 40 and 26 acres, a 17 plus acre riparian woodland on the east quarter-section, and an intermittent stream having two tributaries that periodically flow through both prairie segments and the woodland.

The prairie was grazed heavily during the past 100 years but not to the total loss of native species. By removing livestock, burning and tree removal, native grasses and forbs have become reestablished over much of the area. The area is fenced except along the Ninnescah River. Management by burning and removal of woody vegetation will continue and the spread of native species monitored. At present about 100 acres have been taken out of cultivation and returned to native grasses.

Because the prairie segment is lowland, there are many wallows or temporary marsh habitats. Much of the prairie region is subject to flooding.

The Ninnescah River is a typical sandy plains river. It is cutting away the banks along the west 1/2 mile and mostly depositing along the east 1/2 mile. A large sandbar is developing on the east edge of the property that holds vegetation in early stages of succession by alternation of scouring and deposition. Levees are raised periodically along the east 1/2 mile of the river during major floods. The 10-year flood of October 1985 cut about 10 feet of bank to the west and deposited up to 1 meter of new sand on the levees to the east.

The riparian woodland overlies three river terraces and at least two lateral ponds hold water much of the year in abandoned river channels on these terraces. The 17 acre woodland is an island separated from other woodland both east and west by about 1/2 mile of herbaceous vegetation.

Geologically, an extensive member of the Ninnescah Shale is exposed along the cutting side of the river near the headquarters and at several sites along the intermittent streams. The shale exhibits standard fractures as well as oxidized and reduced zones. The east prairie tributary exhibits a unique pattern of complex meanders and cutoffs that geology classes use for mapping exercises. The soils of the Ninnescah Tract are Elandco silty loam, Renfrow silty clay loam, Tabler silty clay loam and Shellbarger sandy loam.

The only structures on the site at present are the headquarters (16 ft by 70 ft mobile home), a small Butler-type building for housing a tractor and maintenance implements, and a weather station containing a hydrothermograph and wind set. The headquarters can accommodate one or two investigators or a small class including the instructor. For larger educational groups the director or his assistant may serve as guides. Primitive group camping is available at selected sites. Walking trails are under development in the woodland and driving trails follow the perimeter of most of the prairie sites. Potable water is not available because groundwater aquifers contain waters high in calcium, sodium, iron, manganese, and chloride. Future plans are to develop a classroom building and outbuildings for equipment, and rejuvenation of two hand-dug wells.

Use of the Ninnescah Tract is dedicated to both education and research and is utilized by all levels of students and teachers from several disciplines (arts, sciences and education). Long-term studies on prairie recovery and woodland succession have been initiated including graduate studies on rodent composition on burned and unburned prairie sites, interstitial fauna in sandbars along the Ninnescah River, and macrobenthos of temporary streams. Short-term studies are being conducted on prairie succession by undergraduate students and students enrolled in special topics courses (biology, geology, and anthropology). A faunal and floral checklist is being developed. Investigators, classes, ideas, and suggestions and always welcome.

## Reference

Distler, D. A., 1988, Wichita State University Natural area: Kansas Acad. Science Trans., v. 91, no. 1-2, p. 46-47.

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## Figure Captions

A. Native prairie advanced stage of succession (view east)

B. Native prairie advanced stage of succession (view west)

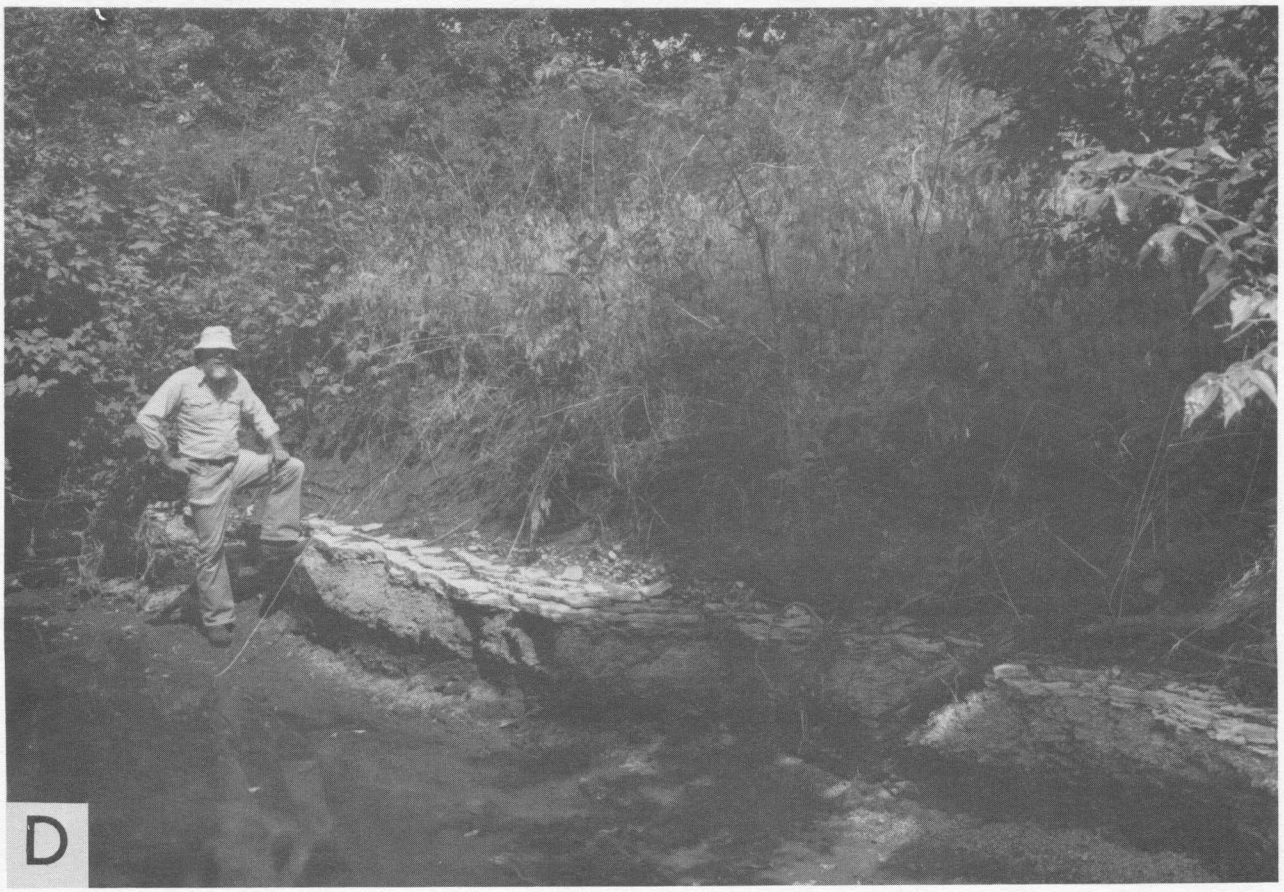
C. Palisade area showing thin upland soils and outcrop of Ninnescah Shale

D. Creek in wooded area with outcrop of limestone bed in Ninnescah Shale


A


B


C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# PRAIRIE NOTES

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The Ninnescah Experimental Tract (NET) is located in the southwest corner of Sedgwick County in the Wellington Lowland physiographic province of Kansas. NET occupies the southeast one-quarter of Section 7 and the southwest one-quarter of Section 8, Township 29S and Range 3W. Elevation is approximately 1,312 feet above mean sea level. Annual precipitation is approximately 29 inches, an average annual temperature of 54°F, and an average frost-free period of 210 days. Soils, derived from both Permian and Quaternary deposits, are of both upland and lowland types. The main upland soil at NET is Renfrow silty clay loam, whereas Tabler silty clay loam, Farnum loam, Elandco silt loam, Canadian sandy loam and Shellabarger sandy loam are the primary lowland type soils. Deeply cut stream channels are common throughout the native prairie areas with stream beds lying as much as ten feet below the adjacent prairie.

The prairie area at NET occur on both upland and lowland soils. The main upland soil, Renfrow silty clay loam, is either currently under wheat cultivation (100 acres) or has recently been taken out of cultivation and planted to native prairie grasses and forbs (100 acres). Native prairie sites, which account for 66 acres, are found on both upland and lowland sites. Upland prairie sites support vegetation dominated by blue grama (Bouteloua gracilis) and sideoats grama (Bouteloua curtipendula).

Lowland prairie sites are dominated by big bluestem (Andropogon gerardi), indiangrass (Sorghastrum avenaceum), switchgrass (Panicum virgatum), sideoats grama and annual bluegrass (Poa annua). Wallows in these native prairie sites are dominated by western wheatgrass (Agropyron smithii).

Some portions of the native prairie area of NET were previously broken for crops and other portions were heavily overgrazed during the past 100 years. Much of the area is in early to mid seral stages of mixed and tallgrass prairie. Grazing was stopped in 1983 and the only management practice now in effect is annual or biannual burning, frequency of burning being dependent upon the amount of fuel on the site in the spring when burning is carried out. On the basis of rainfall and soil type it can be predicted that if and when climax is reached decreasers will be composed approximately of 25-50% big bluestem, 10-25% indiangrass and up to 20% canada wildrye and eastern gamagrass on much of the lowland sites and in addition there should be 10-25% little bluestem on upland sites. Common increasers expected in climax vegetation are switchgrass, western wheatgrass and sedge on lowland sites and in addition blue, hairy and sideoats gramas, as well as tall and sand dropseed on upland sites. A comparison of two areas of lowland prairie has indicated that, based on projected climax, range conditions were poor for overgrazed sites to excellent for sites that had not been impacted by grazing or cropping. A comparison of soil characteristics associated with successional stages indicates that soils under late-

successional prairie have higher organic matter, nitrogen, and phosphorus contents than do early-successional old-field sites.

# GEOLOGY OF THE SOUTH FORK OF THE NINNESCAH TRACT OF WSU

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The attached maps and cross sections will serve to provide background on the geology and geography of the area surrounding the WSU Research area.

The strata in Kansas occur in a series of north-south bands across the state as shown in Fig. 1. Older and lower strata occur to the east and younger or upper strata to the west. The surface of Kansas slopes from an elevation of 4490 ft in Wallace county to about 800 ft at the eastern border of the state, a slope of about 9 ft per mile to the east or about 1/10 of a degree. The strata dip to the west about 1/2 of a degree resulting in the pattern shown in the cross section in Fig. 2. The white area is of Permian age which includes the Wellington formation to the east and the Ninnescah formation to the west.

Fig. 3 is a more detailed map of the larger area. The WSU tract is located in SE 1/4 of Sec. 7 and the SW 1/4 of Sec. 8 in T. 295, R3W. The dashed line is the contact between the Wellington and Ninnescah formations.

Fig. 4 is a cross section, north to south. Columnar section B, illustrates the 7 thin lentils of calcareous beds in the Ninnescah shale formation. This is from a study (1939) by George Norton of the Atlantic Oil Co. The strata in the WSU tract area is at the base of this section.

Fig. 5 and 6 are columnar sections of the Wellington-Ninnescah sections. Fig. 6 is a schematic of the Ninnescah section in Fig. 4. Bed A at the top of the Wellington contains copper deposits malachite - $[(U_2CO_3(OA)2]$ as does Bed 1 of the Ninnescah. Bed A and the contact of the Ninnescah and Wellington formation, may be seen at stops 1 and 2 on the field trip map, Fig. 7. The WSU tract is also shown on this map.

The Wellington and Ninnescah formation were deposited during an arid climate so that very few fossils occur in the strata - more in the Wellington than in the Ninnescah formation. Most of the Wellington shales are green, whereas most of the Ninnescah shales are red. This results from oxidation of the iron pigment, $Fe^{++}$ in the Wellington (green) and $F^{+++}$ in the Ninnescah (red).

Fig. 1. Generalized Geologic Map of Kansas

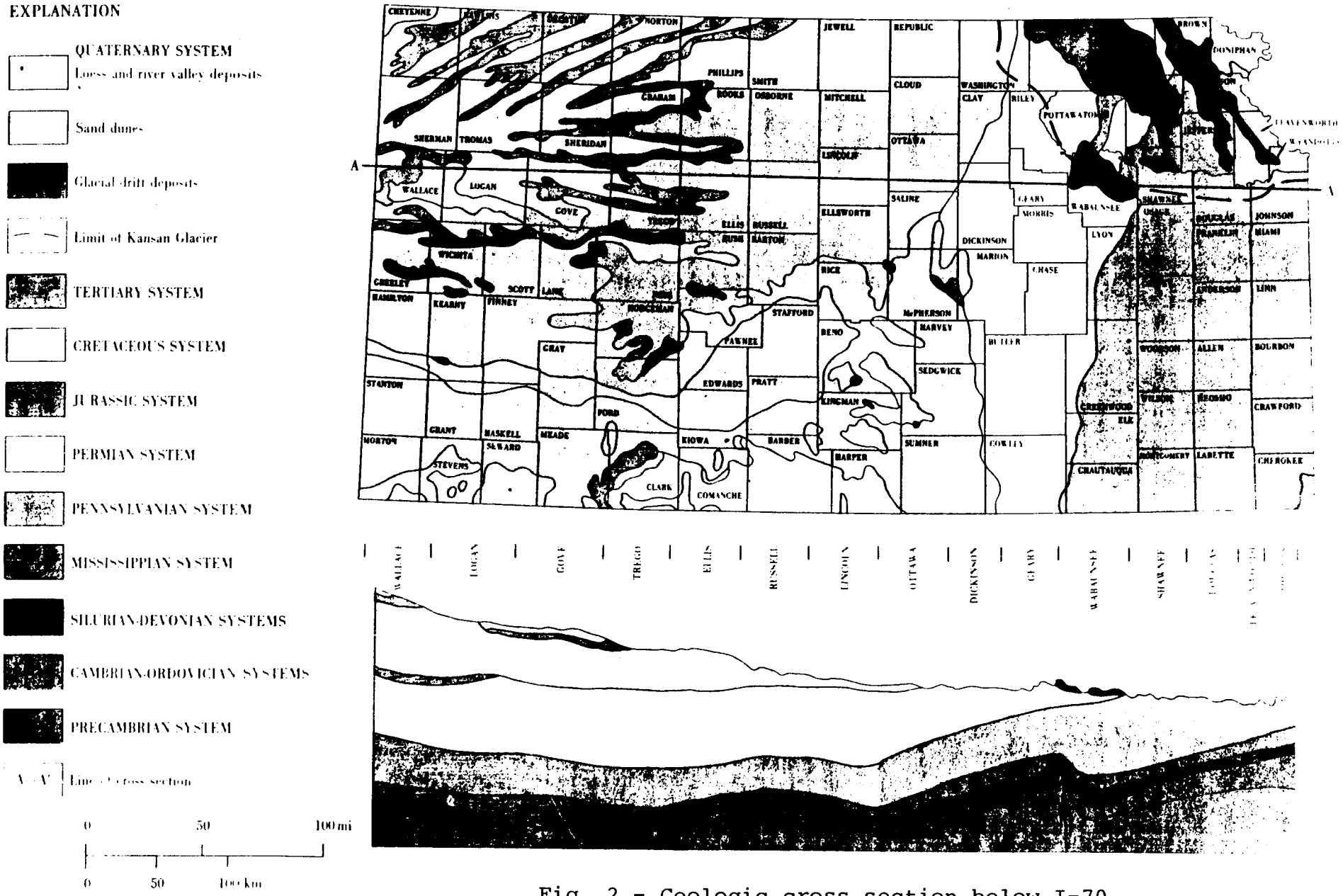


Fig. 2 - Geologic cross section below I-70

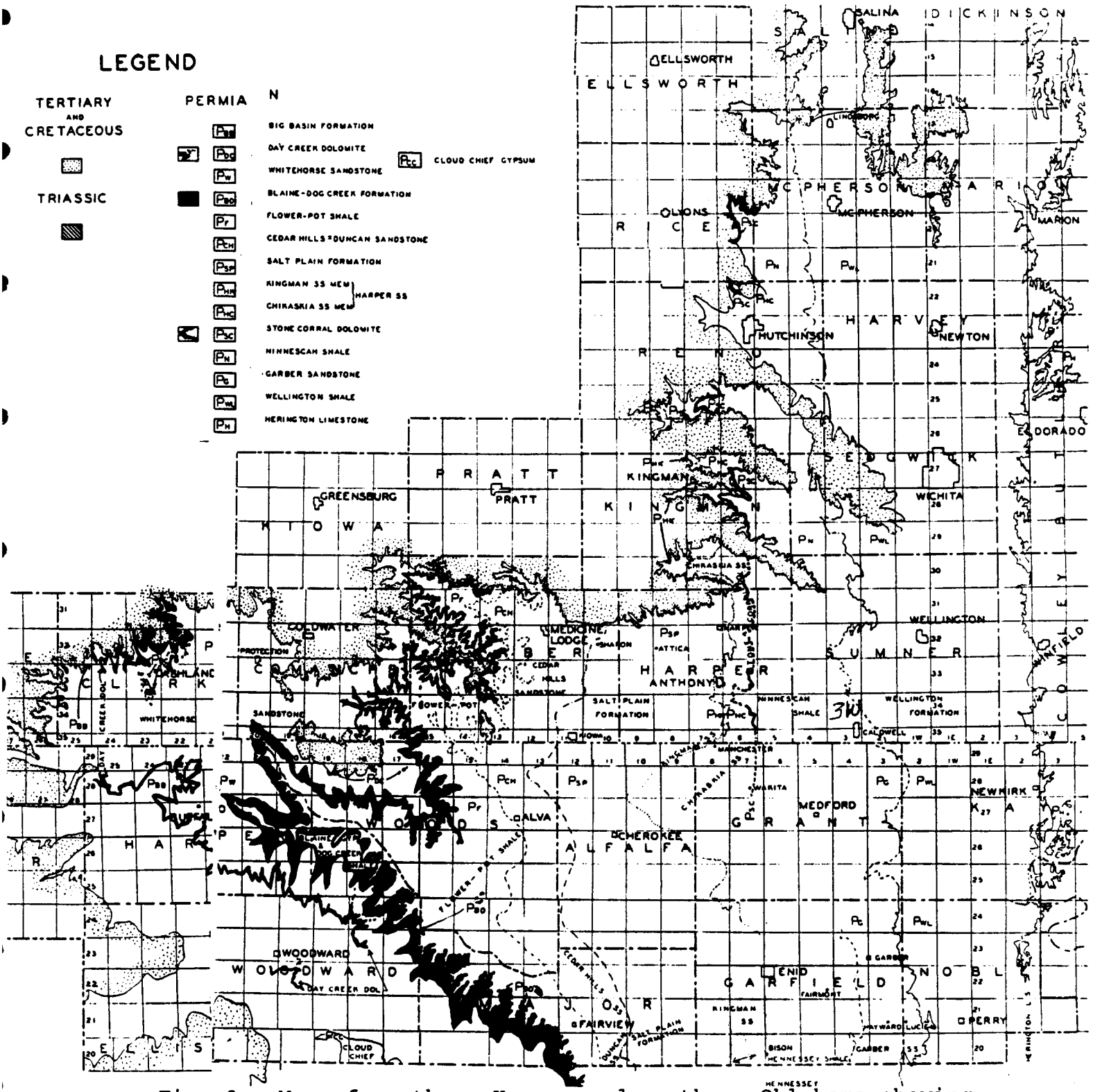


Fig. 3 - Map of southern Kansas and northern Oklahoma showing distribution of subdivisions of redbeds.

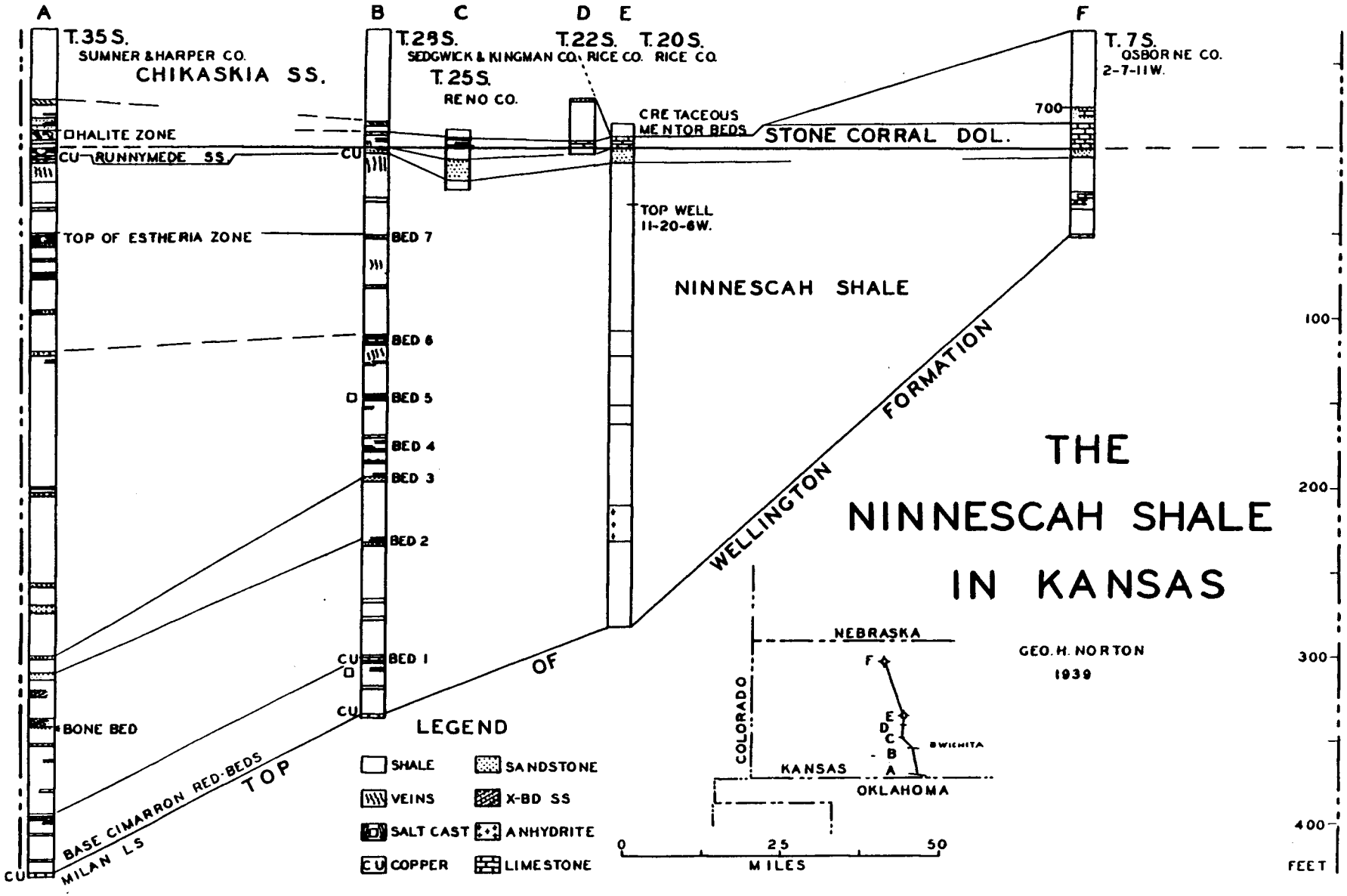


FIG. 4.—Cross section showing subdivision of Ninnescah shale at outcrop, and thinning of formation northward across Kansas.

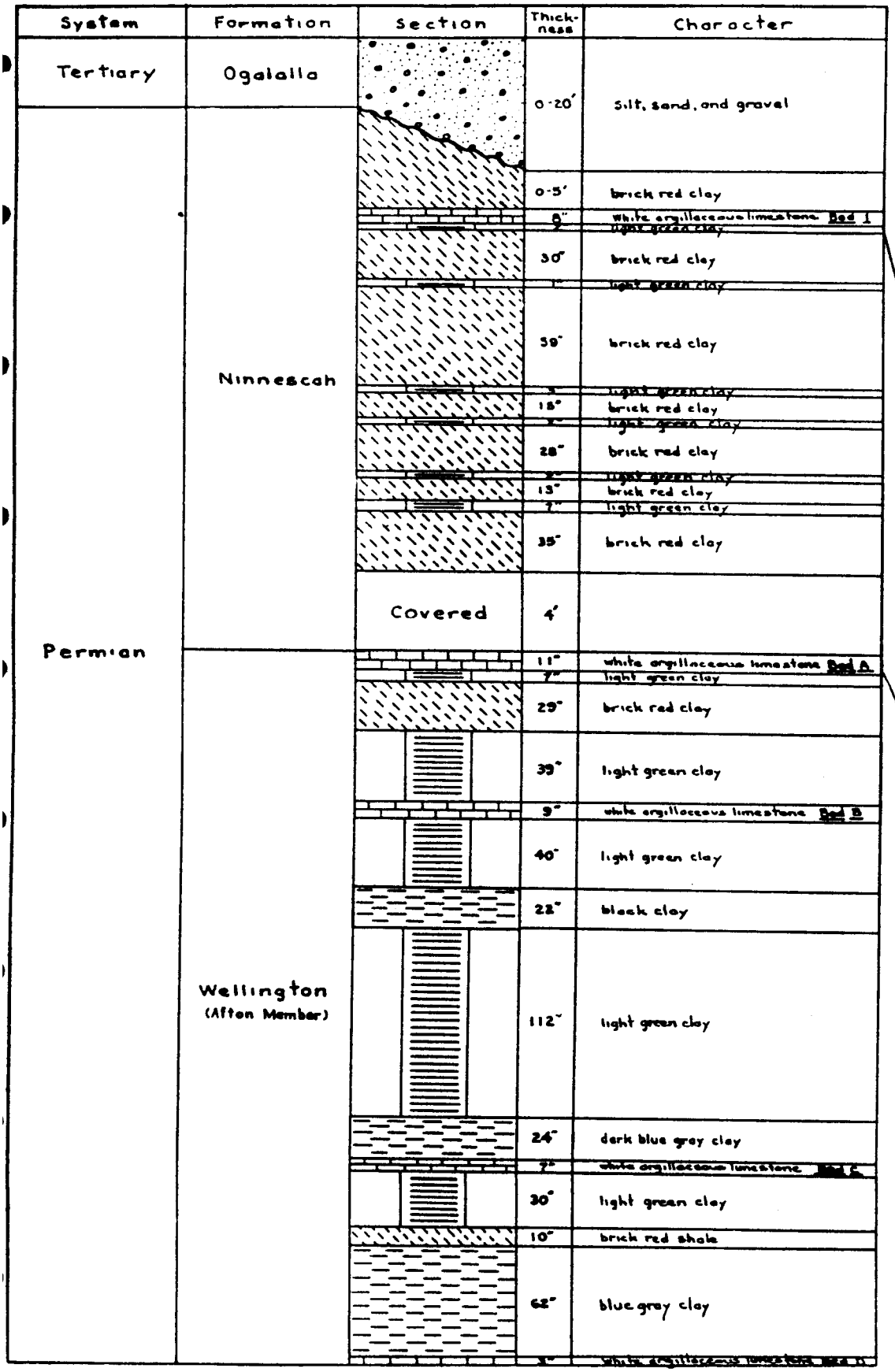


Fig. 5. Lowermost Ninnescah and uppermost Wellington sections

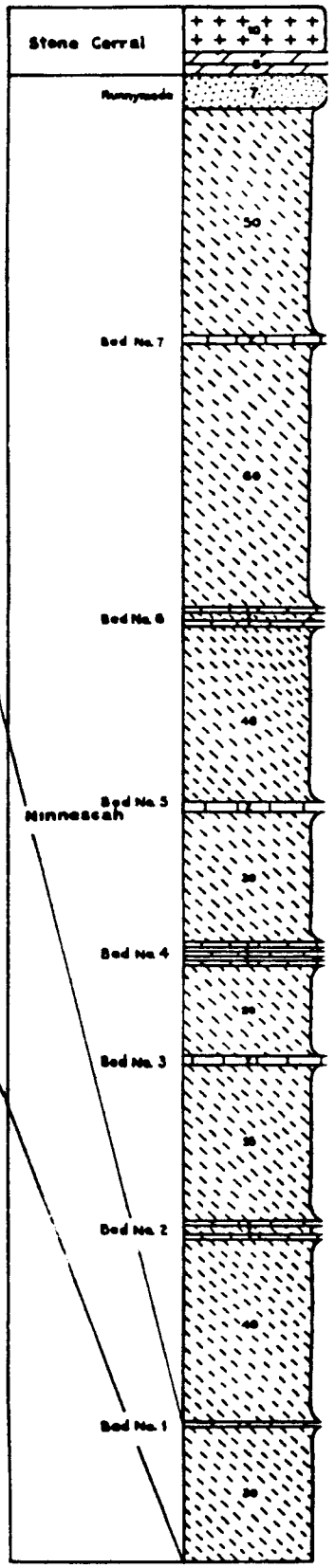


Fig. 6. Complete Ninnescah section

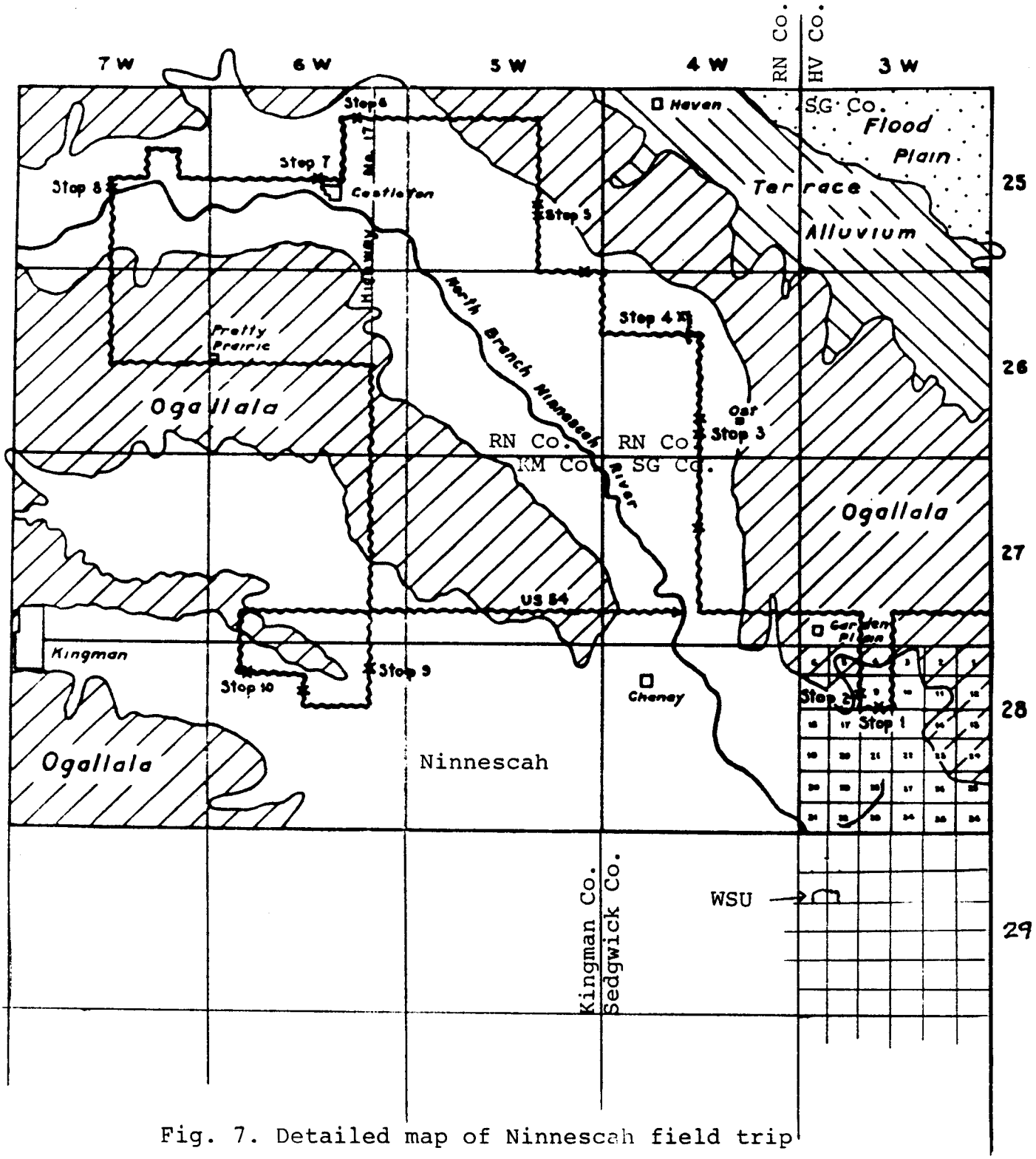


Fig. 7. Detailed map of Ninnescah field trip

# AQUATIC NOTES

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The Ninnescah River defines the northern boundry of the field station. During periods of low water, the pattern of flow is braided. Some sandbars are contiguous with the shore and others occur as everchanging islands. Zones of erosion and deposition occur in almost any small section of the river. The position of pointbars are relatively constant and seem to be correlated with the width of the riverbed. Prior to the development of agriculture in the region and the elimination of prairie fires, herbaceous vegetation extended to the river's edge. At present, there is a discontinuous, narrow riparian border of cottonwood, willow, hackberry, boxelder, and mulberry. Several introduced species have invaded this border since the 1930's: osage-orange, catalpa, Siberian elm, maple, locust, and juniper. With trees stabilizing the channel-width, floods and periodic discharges of a large reservoir on the North Fork have degraded the channel to a depth of 1 to 1.5 meters. This degradation has exposed much of the fauna buried in earlier aggradational cycles (late Pleistocene or early Holocene). More than 20 species of molluscs as well as abundant bison material have been collected in this segment of the river. Currently only two species of molluscs live in the mainstream and a half-dozen more in the muddy substrate of confluent tribuatries.

Almost all the families of fishes represented in Kansas are present in the river but the most numerous large fish is the introduced carp. Although somewhat difficult to net, large numbers of 3 to 5 pound carp can be seen when turbidity is low.

Amphibians of the sandy floodplains include the Great Plains toad, spadefoot toad, Woodhouse's toad, Blanchard's cricket frog, plains leopard frog, and bullfrog.

Reptiles of the river include the snapping turtle, yellow mud turtle, Ouachita map turtle, western painted turtle, red-eared slider and spiny softshell. The ornate box turtle inhabits woodland and prairie sites.

Lizards of the floodplain and riparian border include the eastern fence lizard and the prairie-lined racerunner.

The northern water snake is abundant in the river especially in early summer. Snakes of the prairie and woodland include the eastern yellowbelly racer, black rat snake, bullsnake, prairie kingsnake, red-sided gartersnake, lined snake, and Texas brown snake.

Bird and mammal lists currently are being developed. Bald eagles and osprey migrate through annually. Great blue herons over-wintered in 1986 and 1987 suggesting open water was present throughout both winters.

Rare mammal sitings include red fox, armadillo, and mink.

The unnamed creek that divides the property is intermittent much of the summer and at present is completely dry. The lower course of this stream meanders about 3/4 through prairie and the lower 1/4 through woodland. Above the field station it

drains approximately 8 square miles of agricultural land. Although the bed has degraded about the same depth as the river, black muds dominate the pools and raceways and alternate with shale outcrops in the erosional zones. The stream mouth is mainly a nursery for fishes of the mainstream, but pools throughout the creek are dominated by yellow bullheads, black bullheads, small channel catfish, green sunfish, and mosquitofish. Six species of molluscs have been collected from the creek as well as the chimney-building crayfish.

On submerged solid substrate such as shale, woody vegetation and anthropogenic debris, many orders of insects can be found. These include the immature stages of mayflies, stoneflies, dragon and damsel flies, true bugs, true flies, and beetles. Some larvae of aquatic insects (blood-worms and clubtailed dragonflies) are well adapted to the unstable sand substrates of the river and many small invertebrate species are adapted to the interstitial spaces between sand grains. Most of the insects adapted to the mud substrate of the stream have short life cycles because of the impermanence of the habitat.

# LIMNOLOGIC ANALYSIS OF TWO PONDS AT THE WICHITA STATE UNIVERSITY BIOLOGICAL FIELD STATION

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The Wichita State University

The study of the limnologic aspects of water bodies necessarily requires a multidisciplinary approach. In this preliminary study, we provide an overview of the biogeochemical characteristics of two ponds from The Wichita State University Biological Field Station, and report on chemical and biological analyses conducted on respective pond water samples.

## GEOGRAPHIC AND GEOLOGIC SETTING

Within the confines of the Field Station three ponds are located (Figure 1). Pond 1 is positioned in the SE 1/4, SW 1/4, SE 1/4, Sec. 7, R3W, T29s, Sedgwick County. Located on a meander loop of an unnamed ephemeral stream, Pond 1 appears to be an enlargement (possibly man-made) of the original stream channel, and drains into the Ninnescah River. The stream meanders through 6 $mi^2$ of Sedgwick County and may down-cut a relatively shallow, perched aquifer approximately 2 mi upstream from Pond 1. Water from this stream is the major source of water to Pond 1. The pond is reniform in shape, and when full is approximately 3 ft deep. During July of 1988, the water in Pond 1 was 2 ft deep, whereas during August, the depth was 9 in and its dimensions were 25 ft x 75 ft.

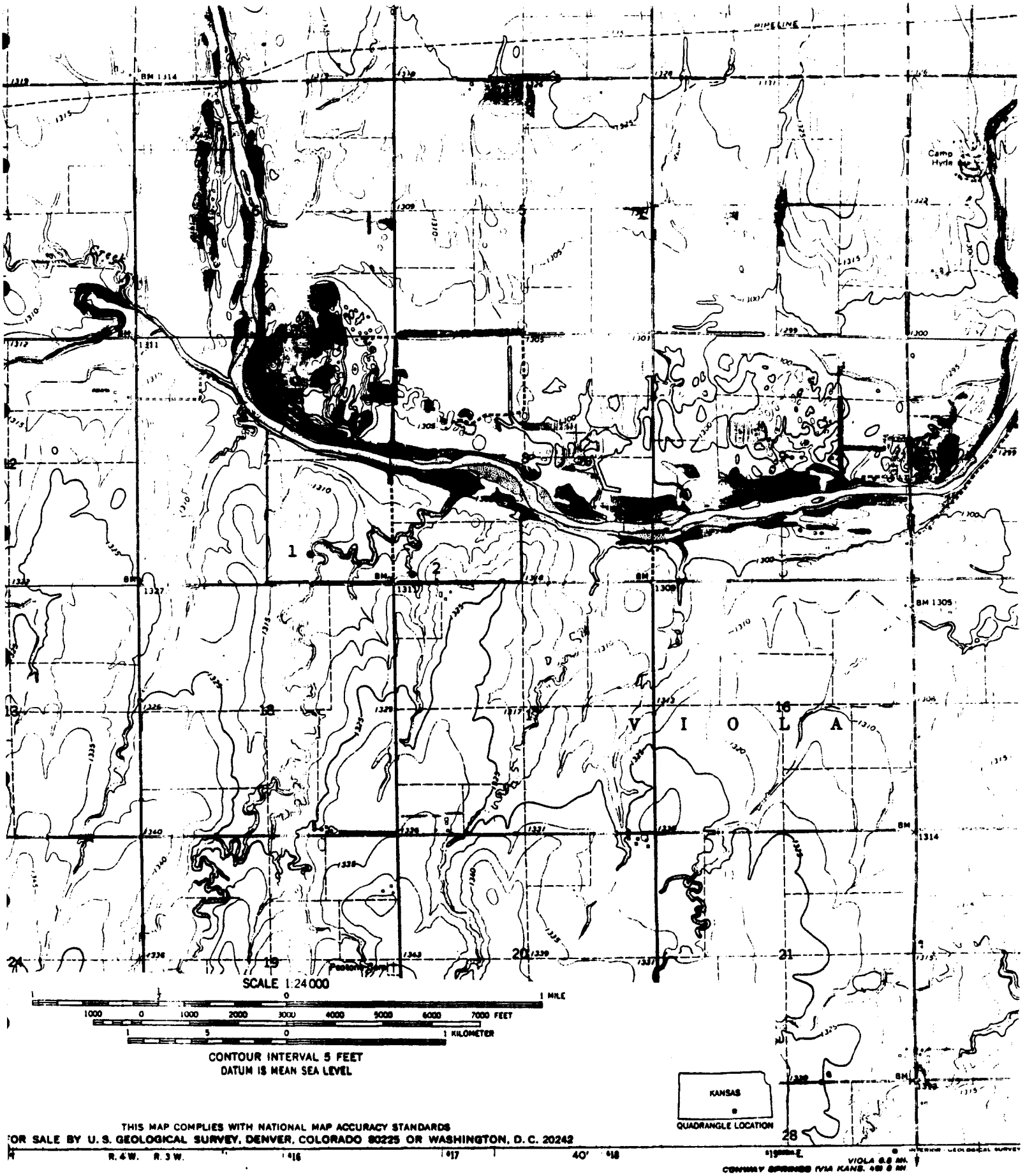


Figure 1. Study area in Sedgwick County, Kansas. The Biological Field Station and Pond locations are indicated.

Pond 2 is located 3/4 of a mile southeast of Pond 1 in the SW 1/4, SW 1/4, SW 1/4, Sec. 8, R3W, T29S, and is man-made and dammed on the north so that open drainage to the Ninnescah is impeded (Figure 1). Source of water for Pond 2 is run-off from a farm pond located approximately 200 ft south of Pond 2. The farm pond connects with an ephemeral stream that originates 1/2 mile south. As a result, both ponds are filled with run-off during periods of precipitation. In spite of a sporadic water source, oval-shaped Pond 2 generally contains water because it is deeper than other ponds at the Field Station. Maximum depth may exceed 8 ft. During the month of July, however, depth of water in Pond 2 was 6 ft. During August the depth was 4 ft and its dimensions were 30 ft x 60 ft.

Between Ponds 1 and 2 lie a set of small, shallow ponds. These ponds were not analyzed because they dried out during the summer as a result of evaporation.

Geologically, both ponds are located in the Ninnescah Shale, Sumner Group, Lower Permian Series. The Ninnescah Formation is a red to grey silty shale that contains thin layers of argillaceous limestone and dolomite, and calcareous siltstone. Average thickness of the unit is 300 ft (Keller, 1968).

## MATERIAL AND METHODS

During July of 1988, five near shore bottom water samples were collected from each of the ponds studied. Each water sample was placed in a clean glass jar, labeled, and stored for laboratory analysis. Of the 5 samples collected, one water

sample from each pond was analyzed for cation concentrations that included Ca, Sr, Na, K, and Mg. Water analysis was conducted on a Perkin-Elmer 2380 atomic absorption spectrophotometer. The remaining 4 samples were analyzed microscopically for biota identification to the family level when possible. Depth of water was estimated.

During August, one water sample was collected and analyzed from each pond both for the cation and anion concentrations. To ensure proper analytical results, temperature readings were taken from each pond and all alkalinity analyses were completed within 24 hours of sampling. With only 9 in of water remaining in Pond 1, the temperature was a relatively homogeneous 86 $^{o}$F. Pond 2 water was stratified. The upper 4 to 6 inches of water was 94 $^{o}$F, whereas the bottom water was 84 $^{o}$F. For both ponds the pH was high. Pond 1 pH was 9.4 and Pond 2 pH was 9.1. Spectrophotometric analysis of each water sample was conducted for cations. Standard titration analysis was conducted to determine the concentration of $Cl^-$ and $HCO_3^-$ anions. The $SO_4$ content was determined by plasma emission spectrometry through analysis of sulfur with an inductively coupled plasma spectrometer (ICP). The shallow lake beds were examined visually for macroscopic organisms.

## RESULTS AND DISCUSSION

Chemical. Results of spectrophotometric analyses for all samples indicate that Pond 1 contains higher concentrations of Ca, Mg, Na, Fe and Sr, whereas Pond 2 contains higher concentrations of K (Table 1). Alkalinity analyses resulted in higher

Table 1. Ionic concentrations of two ponds taken during July and August, 1988.

| Ions | July, 1988 | | August, 1988 | |
|---|---|---|---|---|
| (ppm) | Pond 1 | Pond 2 | Pond 1 | Pond 2 |
| Ca | 43.7 | 23.5 | 58.8 | 22.5 |
| Mg | 24.9 | 9.9 | 31.3 | 12.1 |
| Na | 24.9 | 7.5 | 81.9 | 10.7 |
| K | 5.1 | 5.9 | 8.3 | 11.4 |
| Sr | 0.2 | - | 0.3 | - |
| Cl | * | * | 95.7 | 14.2 |
| HCO3 | * | * | 74.8 | 90.9 |
| CO3 | * | * | 4.9 | 2.8 |
| Fe | * | * | 4.4 | 2.2 |
| SO4 | * | * | 212.0 | 9.9 |

* = analysis not conducted
- = negligible

concentrations of $HCO_3$ in Pond 2, whereas Cl and $CO_3$ concentrations are higher in Pond 1 (Table 1). These results suggest that water from Pond 1 is enriched with ions compared to Pond 2 and that both ponds are enriched with time. Three factors may explain this enrichment.

The water that fills Pond 1 originates from a stream that drains a larger watershed than that of Pond 2. As a result, erosional processes can effect a larger area and more ions can enter the stream that serves as a source for Pond 1. A second consideration is that during the wetter seasons a substantial portion of the stream flow feeding Pond 1 may be derived from shallow, temporary aquifers and delayed return flow of percolating rain water. Longer exposure time to the soil and bedrock would allow more time for ion exchange between water and rock. As a result, salinities would be higher in the groundwater-fed pond than in the pond fed strictly by storm run-off.

A third and perhaps more important factor leading to the enrichment of ions in Pond 1 and through time in both ponds is evaporation. Evaporation tends to concentrate ions in water bodies. In July, the stream was running and Pond 1 contained approximately 24 in of water. By August, the stream that feeds Pond 1 was dry and only 9 in of water remained in the center of the pond. Since rainfall was notably sparse during July and August of 1988, evaporation probably served as the major factor in ionic enrichment. Differences in ionic concentrations between Pond 1 and 2 may be the result of water depth. Although just as

much water evaporated from Pond 2, the man-made pond is nearly twice as deep as Pond 1. As a result, more water is present in Pond 2 to dilute ionic concentrations.

To determine whether the ionic concentrations in both ponds differ as a result of source water chemistry from weathering, groundwater, or as a result of concentration by evaporative processes will require more frequent water sampling and analysis. These analyses should be run on a seasonal basis over a year or more to be valid.

Biological. Results of the biologic census of micro- and macro-organisms indicate that similar taxa live in both ponds. Water samples from the two ponds include abundant cyclopoid Copepods, sessile and free-living Ciliophora, Rotifers, Cladocera and Odonata. Macro-organisms observed on the lake beds include gastropods, shells of Unionidae (Pelecypoda), the aquatic snake Nerodia erythrogaster, and catfish Ictalurus melas. Similarities in taxonomic composition between the two ponds suggests that the widely ranging chemical compositons that characterize the ponds are within the tolerance limits of these taxa.

## CONCLUSION

Chemical compositions of both ponds studied at the Biological Field Station increased in ionic concentrations as a result of evaporative processes. Taxonomic compositions of both ponds are similar in spite of differences in ionic concentrations. The organisms living in the ponds apparently are adapted to fluctuations in water chemistry and have wide

tolerance ranges.

The summer of 1988 was characterized by less than normal precipitation; therefore, results from this study may represent extremely stressful environmental conditions. A broader information base is necessary to unscramble the dynamic complexity of pond ecology at the field station.

# OUTLINE OF THE ARCHAEOLOGICAL SEQUENCE FOR THE REGION OF THE NINNESCAH RESEARCH STATION

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**PALEOINDIAN:** 11,500 - 7,500 years B.P. (before present)

Culture: The first human inhabitants of the continent lived primarily by hunting, with an emphasis on large game -- mammoth and bison in this area. Small groups and high mobility seem to have been the norm.

Diagnostics: Fluted and lanceolate spear points, spurred end scrapers, blade tools.

Where found: Most sites have been destroyed or deeply buried by geomorphic processes. Spear points are sometimes found in reworked sediments in this area of the state.

**ARCHAIC:** 7,500 B.P. - A.D. 1

Culture: The early part of this period saw high temperatures affecting the plains. Few sites have been found, and the extent to which this reflects climate or geomorphology (and hence site visibility) is a moot question. The pattern generally was one of foraging for whatever game was available, supplemented by intensive processing of vegetable foods.

Diagnostics: A large variety of spear point forms are found, many of which were also used as knives; grinding stones, stone-filled hearths.

Where found: Buried in terrace deposits in this area of Kansas.

**EARLY CERAMIC:** A.D. 1 - 1050

Cultures: This period is marked by the addition of small-scale slash and burn horticulture to the foraging base. A pattern of base camps and special purpose camps is known from the eastern part of the state.

Diagnostics: Conical pottery vessels with thick walls, corner notched points, arrow points after A.D. 500.

Where found: Near-surface to deeply buried, frequently at the mouths of small streams. Often associated with a well-developed paleosol.

**MIDDLE CERAMIC:** A.D. 1050 - 1500

Cultures: Hamlets of permanent houses supported by an economy more or less evenly divided between maize horticulture and hunting.

Diagnostics: Globular and flat-bottomed vessels, side-notched arrow points, shaft smoothers. The Bluff Creek complex is the culture found in this region.

Where found: Hamlets are on bluff tops and on terraces.

**LATE CERAMIC:** A.D. 1500-1720

Cultures: Large villages of grass houses supported by horticulture and bison hunting. This is the culture of the Wichita Indians.

Diagnostics: Flat-bottomed ceramic vessels, plain triangular points, blade tools.

Where found: Major villages at Arkansas City, in Rice County, and at Marion; hunting camps widespread.

# ORNITHOLOGY

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The birds of the Ninnescah Research Station and Natural History Reservation have not been systematically studied although records have been kept of some of the birds that have been observed on the area. The following list is a composite one including those birds that have been observed on the reservation (marked with an asterisk *) plus species that should be common in one or more of the major habitats of the reservation. Since early October is a time of migratory movements and the timing of migration may vary from year to year, it is impossible to predict what species will be found on the field trip. However those species that are likely to be on the reservation in early October are marked with a plus (+ after the name).

1. Pied-billed Grebe (Podilymbus podiceps)*+
2. American White Pelican (Pelecanus erythrorhynchos)*
3. Great Blue Heron (Ardea herodias)*+
4. Little Blue Heron (Egretta caerulea)*
5. Green-backed Heron (Butorides striatus)*+

6. Snow Goose (Chen caerulescens)*+
7. Canada Goose (Branta canadensis)*+
8. Wood Duck (Aix sponsa)*+
9. Mallard (Anas platyrhynchos)*+
10. Northern Pintail (Anas acuta)*+
11. Blue-winged Teal (Anas discors)*+
12. Northern Shoveler (Anas clypeata)*+
13. Lesser Scaup (Aythya affinis)*+
14. Common Goldeneye (Bucephala clangula)*
15. Bufflehead (Bucephala albeola)*
16. Common Merganser (Mergus merganser)*

17. Turkey Vulture (Cathartes aura)*
18. Bald Eagle (Haliaeetus leucocephalus)*
19. Osprey (Pandion haliaetus)*

20. Northern Harrier (Circus cyaneus)*+
21. Sharp-shinned Hawk (Accipiter striatus)*+
22. Swainson's Hawk (Buteo swainsoni)*
23. Red-tailed Hawk (Buteo jamaicensis)*+
24. Rough-legged Hawk (Buteo lagopus)*
25. American Kestrel (Falco sparverius)*+

26. Ring-necked Pheasant (Phasianus colchicus)*+
27. Wild Turkey (Meleagris gallopavo)*+
28. Northern Bobwhite (Colinus virginianus)*+

29. Sora (Porzana carolina)*
30. American Coot (Fulica americana)*+
31. Sandhill Crane (Grus canadensis)*

32. Killdeer (Charadrius vociferus)*+
33. Greater Yellowlegs (Tringa melanoleuca)+
34. Lesser Yellowlegs (Tringa flavipes)+
35. Solitary Sandpiper (Tringa solitaria)
36. Spotted Sandpiper (Actitis macularia)*
37. Upland Sandpiper (Bartramia longicauda)*
38. Least Sandpiper (Calidris minutilla)*
39. Pectoral Sandpiper (Calidris melanotos)+
40. Common Snipe (Gallinago gallinago)*+
41. Franklin's Gull (Larus pipixcan)*+
42. Ring-billed Gull (Larus delawarensis)*
43. Herring Gull (Larus argentatus)*
44. Common Tern (Sterna hirundo)*
45. Black Tern (Chlidonias niger)*

46. Mourning Dove (Zenaida macroura)*+
47. Yellow-billed Cuckoo (Coccyzus americanus)*

48. Eastern Screech-owl (Otus asio)*+
49. Great Horned Owl (Bubo virginianus)*+

50. Common Nighthawk (Chordeiles minor)*+
51. Chuck-will's-widow (Caprimulgus carolinensis)*
52. Chimney Swift (Chaetura pelagica)*+
53. Belted Kingfisher (Ceryle alcyon)*+

54. Red-headed Woodpecker (Melanerpes erythrocephalus)*
55. Red-bellied Woodpecker (Melanerpes carolinus)*+
56. Yellow-bellied Sapsucker (Sphyrapicus varius)*+
57. Downy Woodpecker (Picoides pubescens)*+
58. Hairy Woodpecker (Picoides villosus)*+
59. Northern Flicker (Colaptes auratus)*+

60. Eastern Wood-pewee (Contopus virens)
61. Least Flycatcher (Empidonax minimus)
62. Eastern Phoebe (Sayornis phoebe)
63. Great Crested Flycatcher (Myiarchus crinitus)
64. Western Kingbird (Tyrannus verticalis)*
65. Eastern Kingbird (Tyrannus tyrannus)*
66. Scissor-tailed Flycatcher (Tyrannus forficatus)*+

67. Horned Lark (Eremophila alpestris)*+
68. Purple Martin (Progne subis)*
69. Northern Rough-winged Swallow (Stelgidopteryx serripennis)
70. Bank Swallow (Riparia riparia)*
71. Barn Swallow (Hirundo rustica)*

72. Blue Jay (Cyanocitta cristata)*+
73. American Crow (Corvus brachyrhynchos)*+
74. Black-capped Chickadee (Parus atricapillus)*+
75. Carolina Chickadee (Parus carolinensis)*+
76. Tufted Titmouse (Parus bicolor)*+
77. White-breasted Nuthatch (Sitta carolinensis)+
78. Brown Creeper (Certhia americana)*

79. Carolina Wren (Thryothorus ludovicianus)*+
80. House Wren (Troglodytes aedon)
81. Golden-crowned Kinglet (Regulus satrapa)
82. Ruby-crowned Kinglet (Regulus calendula)+
83. Blue-gray Gnatcatcher (Polioptila caerulea)+

84. Eastern Bluebird (Sialia sialis)*+
85. Swainson's Thrush (Catharus ustulatus)+
86. American Robin (Turdus migratorius)*+

87. Gray Catbird (Dumetella carolinensis)*
88. Northern Mockingbird (Mimus polyglottos)*+
89. Brown Thrasher (Toxostoma rufum)*+
90. Cedar Waxwing (Bombycilla cedrorum)*+
91. Loggerhead Shrike (Lanius ludovicianus)*+
92. European Starling (Sturnus vulgaris)*+

93. Bell's Vireo (Vireo bellii)
94. Warbling Vireo (Vireo gilvus)
95. Tennessee Warbler (Vermivora peregrina)+
96. Orange-crowned Warbler (Vermivora celata)+
97. Nashville Warbler (Vermivora ruficapilla)+
98. Yellow Warbler (Dendroica petechia)
99. Yellow-rumped Warbler (Dendroica coronata)
100. Common Yellowthroat (Geothlypis trichas)
101. Wilson's Warbler (Wilsonia pusilla)

102. Northern Cardinal (Cardinalis cardinalis)*+
103. Rose-breasted Grosbeak (Pheucticus ludovicianus)
104. Blue Grosbeak (Guiraca caerulea)
105. Lazuli Bunting (Passerina amoena)*
106. Indigo Bunting (Passerina cyanea)
107. Dickcissel (Spiza americana)*
108. Rufous-sided Towhee (Pipilo erythrophthalmus)+

109. American Tree Sparrow (Spizella arborea)*
110. Chipping Sparrow (Spizella passerina)*+
111. Clay-colored Sparrow (Spizella pallida)+
112. Field Sparrow (Spizella pusilla)+

113. Vesper Sparrow (Pooecetes gramineus)+
114. Lark Sparrow (Chondestes grammacus)
115. Savannah Sparrow (Passerculus sandwichensis)+
116. Grasshopper Sparrow (Ammodramus savannarum)*
117. Song Sparrow (Melospiza melodia)*+
118. Lincoln's Sparrow (Melospiza lincolnii)+
119. White-throated Sparrow (Zonotrichia albicollis)+
120. White-crowned Sparrow (Zonotrichia leucophrys)*+
121. Harris' Sparrow (Zonotrichia querula)*+
122. Fox Sparrow (Passerella iliaca)*
123. Dark-eyed Junco (Junco hyemalis)*+
124. Lapland Longspur (Calcarius lapponicus)*

125. Red-winged Blackbird (Agelaius phoeniceus)*+
126. Eastern Meadowlark (Sturnella magna)+
127. Western Meadowlark (Sturnella neglecta)*+
128. Great-tailed Grackle (Quiscalus mexicanus)*
129. Common Grackle (Quiscalus quiscula)*+
130. Brown-headed Cowbird (Molothrus ater)*+
131. Northern Oriole (Icterus galbula)*

132. Pine Siskin (Carduelis pinus)*
133. American Goldfinch (Carduelis tristis)*+
134. House Sparrow (Passer domesticus)*+

PRELIMINARY CHECKLIST OF VASCULAR PLANTS OF THE NINNESCAH EXPERIMENTAL TRACT
Based on collections and field observations of various sources,
compiled by Ellie Skokan, Sept. 26, 1988
Nomenclature from The Great Plains Flora Association, 1986,
Flora of the Great Plains, Lawrence, Ks., Univ. Press of Kansas

ACANTHACEAE (Acanthus Family)
Ruellia humilis Nutt. (fringeleaf ruellia). Prairie.

ACERACEAE (Maple Family)
Acer negundo L. (boxelder). Woods, river, prairie streams.
Acer saccharinum L. (silver maple, soft maple). Old homestead.

AMARANTHACEAE (Pigweed Family)
Amaranthus albus L. (tumble weed). Disturbed areas.
Amaranthus graecizans L. (prostrate pigweed). Disturbed areas.
Amaranthus hybridus L. (slender pigweed, green pigweed). Disturbed areas.
Amaranthus retroflexus L. (rough pigweed). Disturbed areas.
Froelichia floridana (Nutt.) Moq. (field snake-cotton). Prairie/woods edge.

ANACARDIACEAE (Cashew Family)
Rhus aromatica Ait. (fragrant sumac, polecat bush). Woods.
Rhus glabra L. (smooth sumac). Edge, fences.
Toxocodendron radicans (L.) O. Ktze (poison ivy). Woods, fences.

APIACEAE (Parsley Family)
Chaerophyllum procumbens (L.) Crantz (wild chervil). Woods.
Conium maculatum L. (poison hemlock). Woods.
Daucus carota L. (wild carrot, Queen Anne's lace). Prairie.
Torilis arvensis (Huds.) Link (hedge parsley). Prairie, disturbed areas.

APOCYNACEAE (Dogbane Family)
Apocynum cannabinum L. (Indian hemp dogbane). Prairie.

ASCLEPIADACEAE (Milkweed Family)
Asclepias incarnata L. (swamp milkweed). Prairie, floodplain.
Asclepias latifolia (Torr.) Raf. (broadleaf milkweed). Prairie.
Asclepias pumila (A. Gray) Vail (plains milkweed). Prairie.
Asclepias speciosa Torr. (showy milkweed). Roadsides.
Asclepias stenophylla A. Gray (narrow-leaved milkweed). Prairie.
Asclepias syriaca L. (common milkweed). Prairie.
Asclepias tuberosa L. (butterfly milkweed). Prairie.
Asclepias verticillata L. (whorled milkweed). Prairie.
Asclepias viridis Walt. (spider milkweed). Prairie.
Cynanchum laeve (Michx.) Pers. (sand vine, climbing milkweed).

ASTERACEAE (Aster Family)

Achillea millefolium L. (yarrow). Prairie.
Ambrosia artemisiifolia L. (common ragweed, short ragweed). Prairie, disturbed areas.
Ambrosia psilostachya DC. (western ragweed). Prairie, disturbed areas.
Ambrosia trifida L. (giant ragweed). Disturbed areas.
Artemesia ludoviciana Nutt. (white sagewort). Prairie.
Aster ericoides L. (white aster). Prairie.
Aster oblongifolius Nutt. (aromatic aster). Prairie.
Bidens frondosa L. (beggar-ticks). Disturbed areas.
Cirsium altissimum (L.) Spreng. (tall thistle, roadside thistle). Disturbed areas.
Cirsium undulatum (Nutt.) Spreng. (wavy-leaf thistle). Prairie.
Cirsium vulgare (Savi) Ten. (bull thistle). Prairie.
Conyza canadensis (L.) Cronq. (horse-weed). Prairie, disturbed areas.
Conyza ramosissima Cronq. (spreading fleabane). Prairie, disturbed areas.
Coreopsis tinctoria Nutt. (plains coreopsis). Wet prairie.
Dyssodia papposa (Vent) Hitchc. (fetid marigold). Disturbed areas.
Erigeron annuus (L.) Pers. (annual fleabane). Prairie, disturbed areas.
Erigeron strigosus Muhl. ex Willd. (daisy fleabane). Prairie disturbed areas.
Eupatorium altissimum L. (tall eupatorium). Prairie.
Eupatorium rugosum Houtt. (white snakeroot). Woods.
Gnaphalium obtusifolium L. (fragrant cudweed, fragrant everlasting). Roadside.
Gutierrezia dracunculoides (DC) Blake (broomweed). Prairie.
Haplopappus ciliatus (Nutt.) DC. (goldenweed). Disturbed areas.
Helianthus annuus L. (common sunflower). Disturbed areas.
Helianthus maximilianii Schrad. (Maximilian sunflower). Prairie.
Helianthus petiolaris Nutt. (plains sunflower). Prairie.
Helianthus tuberosus L. (Jerusalem artichoke). Prairie, edge.
Heterotheca latifolia Buckl. (camphorweed). Sandbars.
Iva annua L. (marsh elder). Disturbed areas.
Kuhnia eupatorioides L. (false boneset). Prairie.
Lactuca canadensis L. (wild lettuce). Prairie.
Lactuca ludoviciana (Nutt.) Ridd. (western wild lettuce). Prairie.
Lactuca serriola L. (prickly lettuce). Prairie.
Liatris punctata Hook. (dotted gayfeather). Prairie.
Lygodesmia juncea (Pursh) Hook (skeletonplant). Prairie.
Ratibida columnifera (Nutt.) Woot. & Standl. (prairie coneflower). Prairie.
Rudbeckia hirta L. (black-eyed susan). Prairie.
Silphium integrifolium Michx. (showy rosinweed). Prairie
Solidago gigantea Ait. (late goldenrod). Prairie.
Solidago missouriensis Nutt. (prairie goldenrod). Prairie.
Solidago rigida L. (rigid goldenrod). Prairie.
Sonchus asper (L.) Hill (prickly sow thistle). Prairie.
Taraxacum officinale Weber (common dandelion). Prairie.
Tragopogon dubius Scop. (goat's beard, western salsify). Prairie.
Vernonia baldwinii Torr. (Baldwin's ironweed, western ironweed). Prairie.
Xanthium strumarium L. (cocklebur). Disturbed areas.

BIGNONIACEAE (Trumpet Creeper Family)

Catalpa speciosa Warder (northern catalpa, hardy catalpa, Catawba-tree). Woods, river.

BORAGINACEAE (Borage Family)

Lithospermum arvense L. (corn gromwell). Prairie.
Lithospermum carolinense (Walt.) MacM. (puccoon). Prairie.

BRASSICACEAE (Mustard Family)

Barbarea vulgaris R. Br. (winter cress). Disturbed areas.
Brassica juncea (L.) Czern. (Indian mustard). Disturbed areas.
Capsella bursa-pastoris (L.) Medic. (shepherd's purse). Disturbed areas.
Descurainia pinnata (Walt.) Britt. (tansy mustard). Disturbed areas.
Erysimum repandum L. (bushy wallflower). Disturbed areas.
Lepidium densiflorum Schrad. (peppergrass). Disturbed areas.
Rorippa sinuata (Nutt.) Hitchc. (spreading yellow cress). Disturbed areas.
Sisymbrium altissimum L. (tumbling mustard). Disturbed areas.
Thlaspi arvense L. (field pennycress). Disturbed areas.

CACTACEAE (Cactus Family)

Opuntia macrorhiza Engelm. (plains prickly pear). Prairie.

CAESALPINIACEAE (Caesalpinia Family)

Cassia chamaecrista L. (showy partridge pea). Prairie.
Cassia marilandica L. (Maryland senna). Prairie.
Cercis canadensis L. (redbud). Woods, river, prairie streams.
Gleditsia trancanthos L. (honey locust). Floodplain.

CAMPANULACEAE (Bellflower Family)

Triodanis perfoliata (L.) Nieuw. (Venus' looking-glass). Prairie, disturbed areas.

CAPPARACEAE (Caper Family)

Polanisia dodecandra (L.) DC. subsp. trachysperma (T.& G.) Iltis (clammyweed). Riverbank, sandbars.

CAPRIFOLIACEAE (Honeysuckle Family)

Sambucus canadensis L. (common elderberry). Woods, prairie streams.
Symphoricarpos orbiculatus Moench (coralberry, buckbrush). Woods.

CARYOPHYLLACEAE (Pink Family)

Cerastium brachypodum (Engelm.ex A. Gray) Robins. (cerastium). Disturbed areas.
Stellaria media (L.) Cyr. (common chickweed). Disturbed areas.

CHENOPODIACEAE (Goosefoot Family)

Chenopodium album L. (lamb's-quarters). Disturbed areas.
Chenopodium gigantospermum Aellen (maple-leaved goosefoot). Disturbed areas.
Cycloloma atriplicifolium (Spreng.) Coult. (tumble ringweed, winged pigweed). Sandbars.
Kochia scoparia (L.) Schrad. (kochia, fire-weed, summer or mock cypress). Disturbed areas.
Salsola iberica Senn. & Pau. (Russian thistle, tumbleweed). Disturbed areas.

COMMELINACEAE (Spiderwort Family)

Commelina erecta L. (erect dayflower). Sandbars.
Tradescantia sp. L. (spiderwort). Prairie.

CONVOLVULACEAE (Morning-glory Family)

Calystegia sepium (L.) R. Br. (hedge bindweed). Prairie.
Convolvulus arvensis L. subsp. angulata Brummitt (field bindweed). Prairie.
Ipomoea hederacea Jacq. (ivyleaf morning-glory). Edge, disturbed areas.
Ipomoea leptophylla Torr. (bush morning-glory). Prairie.

CORNACEAE (Dogwood Family)

Cornus drummondii C. A. Mey. (roughleaved dogwood). Woods, river, prairie streams.

CUCURBITACEAE (Cucumber Family)

Cucurbita foetidissima H.B.K. (buffalo gourd). Prairie, disturbed areas.

CUPRESSACEAE (Cypress Family)

Juniperus virginiana L. (red cedar). Woods, river, and prairie streams.

CUSCUTACEAE (Dodder Family)

Cuscuta cuspidata Engelm. (cusp dodder). Prairie.

CYPERACEAE (Sedge Family)

Carex sp. L. (sedge). Prairie, floodplain, Sandbars.
Cyperus esculentus L. (umbrella sedge). Prairie.

EQUISETACEAE (Horsetail Family)

Equisetum laevigatum A. Br. (smooth scouring rush). Prairie streams.

EUPHORBIACEAE (Spurge Family)

Acalypha virginica L. (three-seeded mercury). Prairie.
Croton capitatus Michx. (woolly croton). Prairie.
Croton monanthogynus Michx. (one-seeded croton). Prairie.
Croton texensis (Kl.) Muell. Arg. (Texas croton). Prairie.
Euphorbia corollata L. (flowering spurge). Prairie.
Euphorbia cyanthophora Murray (fire-on-the-mountain, painted euphorbia). Prairie, sandbars.
Euphorbia dentata Michx. (toothed spurge). Prairie, disturbed areas.
Euphorbia hexagona Nutt. ex Spreng. (six-angled spurge).
Euphorbia maculata L. (spotted spurge). Prairie, disturbed areas, sandbars.
Euphorbia marginata Pursh (snow-on-the-mountain). Prairie.
Euphorbia missurica Raf. (Missouri spurge, prairie spurge).

FABACEAE (Bean Family)

Amorpha canescens Pursh (lead plant). Prairie.
Amorpha fruticosa L. (false indigo). Prairie stream.
Astragalus crassicarpus Nutt. (ground plum). Prairie.
Baptisia australis (L.) R. Br. var. minor (Lehm.) S. Wats. (blue false indigo). Prairie
Baptisia bracteata Muhl. ex Ell. var. glabrescens (Larisey) Isley (plains wild indigo, long bracted wild indigo). Prairie.
Coronilla varia L. (crown vetch). Riverbank.

Dalea candida Michx. ex Willd. (white prairie clover). Prairie.
Desmodium illinoense A. Gray (Illinois tickclover). Prairie.
Glycyrrhiza lepidota Pursh (wild licorice). Prairie.
Medicago lupulina L. (black medic). Prairie.
Medicago sativa L. ssp. sativa (alfalfa). Old homestead, sandbars.
Melilotus alba Medic. (white sweet clover). Prairie
Melilotus officinalis (L.) Pall. (yellow sweet clover). Prairie.
Psoralea argophylla Pursh (silverleaf scurfpea). Prairie.
Psoralea tenuiflora Pursh (wild alfalfa, scurfy pea). Prairie.
Robinia pseudo-acacia L. (black locust). Old homestead.
Strophostyles leiosperma (T. & G.) Piper (slick-seed bean). Prairie.
Trifolium pratense L. (red clover). Prairie.

FUMARIACEAE (Fumitory Family)
Corydalis curvisiliqua Engelm. subsp. grandibracteata (Fedde) G. Ownbey (large-bracted corydalis). Woods.

GERANIACEAE (Geranium Family)
Geranium carolinianum L. (Carolina cranesbill). Disturbed areas.

GROSSULARIACEAE (Current Family)
Ribes odoratum Wendl. (buffalo current). Woods, river, prairie streams.

IRIDACEAE (Iris Family)
Sisyrinchium campestre Bickn. (white-eyed grass). Prairie.

JUNCACEAE (Rush Family)
Juncus dudleyi Wieg. (Dudley rush). Prairie.

LAMIACEAE (Mint Family)
Lamium amplexicaule L. (henbit). Disturbed areas.
Monarda citriodora Cerv. ex Lag. (lemon beebalm, lemon mint). Sandbars.
Salvia azurea Lam. (blue sage, Pitcher sage). Prairie.
Salvia reflexa Hornem. (Rocky Mountain sage, lance-leaved sage). Disturbed areas.
Teucrium canadense L. (American germander, wood sage). Shaded roadway.

LILIACEAE (Lily Family)
Allium canadense L. (wild onion). Prairie.
Nothoscordum bivalve (L.) Britt. (false garlic). Prairie.

LYTHRACEAE (Loosestrife Family)
Ammannia coccinea Rottb. (toothcup). Riverbanks.
Lythrum californicum T. & G. (California loosestrife).

MALVACEAE (Mallow Family)
Abutilon theophrasti Medic. (velvet-leaf). Disturbed areas.
Callirhoe alcaeoides (Michx.) A. Gray (pale poppy mallow). Prairie.
Callirhoe involucrata (T. & G.) A. Gray (purple prairie mallow). Prairie.
Hibiscus trionum L. (flower-of-an-hour, Venice mallow). Prairie.
Malva neglecta Wallr. (common mallow). Prairie.

MIMOSACEAE (Mimosa Family)

Desmanthus illinoensis (Michx.) MacM. (Illinois bundleflower). Prairie.

Schrankia nuttallii (DC.) Standl. (sensitive brier, catclaw sensitive brier). Prairie.

MOLLUGINACEAE (Carpetweed Family)

Mullugo verticillata L. (carpetweed).

MORACEAE (Mulberry Family)

Maclura pomifera (Raf.) Schneid. (Osage orange). Woods, river, prairie streams, fence lines.

Morus rubra L. (red mulberry). Woods, river, prairie streams.

NYCTAGINACEAE (Four-o'clock Family)

Mirabilis nyctaginea (Michs.) MacM. (wild four-o'clock). Disturbed areas, woods edge.

OLEACEAE (Olive Family)

Fraxinus pennsylvanica Marsh. (green ash). Woods, river, prairie streams.

ONAGRACEAE (Evening primrose Family)

Gaura parviflora Dougl. (velvety gaura). Prairie.

Oenothera biennis L. (common evening primrose). Prairie, disturbed areas.

Oenothera laciniata Hill. (cut-leaved evening primrose). Disturbed areas.

Oenothera rhombipetala Nutt. ex T. & G. (fourpoint evening primrose). Sandbars.

Oenothera speciosa Nutt. (showy white evening primrose). Prairie.

Oenothera triloba Nutt. (stemless evening primrose). Prairie.

Stenosiphon linifolius (Nutt.) Heynh. (stenosiphon). Prairie.

OXALIDACEAE (Wood Sorrel Family)

Oxalis stricta L. (yellow wood sorrel). Prairie.

PAPAVERACEAE (Poppy Family)

Argemone polyanthemos (Fedde) G. Ownbey (prickly poppy). Woods.

PEDALIACEAE (Unicorn-plant Family)

Proboscidea louisianica (P. Mill.) Thell. (devil's claw, unicorn plant). Disturbed areas.

PHYTOLACCACEAE (Pokeweed Family)

Phytolacca americana L. (pokeweed).

PLANTAGINACEAE (Plaintain Family)

Plantago patagonica Jacq. (Patagonian plantain).

POACEAE (Grass Family)

Aegilops cylindrica Host (jointed goatgrass). Disturbed areas.

Agropyron smithii Rydb. (western wheatgrass). Prairie wallows.

Andropogon gerardii Vitman (big bluestem). Prairie.

Andropogon saccharoides Sw. var. torreyanus (Steud.) Hack. (silver bluestem)

Andropogon scoparius Michx. (little bluestem). Prairie.

Aristida oligantha Michx. (oldfield three-awn prairie three-awn). Disturbed areas.

Bouteloua curtipendula (Michx.) Torr. (sideoats grama). Prairie.
Bouteloua gracilis (H.B.K.) Lag. ex Griffiths (blue grama). Prairie.
Bromus inermis Leyss. subsp. inermis (smooth brome). Prairie.
Bromus japonicus Thunb. ex Murr. (Japanese brome). Disturbed areas.
Bromus tectorum L. (downy brome). Prairie, disturbed areas.
Buchloe dactyloides (Nutt.) Engelm. (buffalo grass)
Cenchrus longispinus (Hack.) Fern. (longspine sandbur). Disturbed areas, sandbars.
Chloris verticillata Nutt. (windmill grass). Prairie.
Cynodon dactylon (L.) Pers. (Bermuda grass). Driveway.
Dicanthelium oligosanthes (Schult.) Gould var. scribnerianum (Nash) Gould (Schribner dicanthelium)
Digitaria ischaemum (Schreb. ex Schweigg) Schreb. ex Muhl. (smooth crabgrass). Disturbed areas.
Digitaria sanguinalis (L.) Scop. (hairy crabgrass). Disturbed areas.
Echinochloa crusgalli (L.) Beauv. (barnyard grass). Disturbed areas.
Eleusine indica (L.) Gaertn. (goosegrass). Disturbed areas.
Elymus canadensis L. (Canada wild rye). Disturbed areas.
Elymus virginicus L. (Virginia wild rye). Prairie/woods edge.
Eragrostis cilianensis (All.) E. Mosher (stinkgrass). Disturbed areas.
Eragrostis spectabilis (Pursh) Steud. (purple lovegrass). Prairie.
Eragrostis trichodes (Nutt.) Wood (sand lovegrass). Sandbar.
Festuca octoflora Walt. (sixweeks fescue). Prairie.
Hordeum jubatum L. (foxtail barley). Disturbed areas.
Hordeum pusillum Nutt. (little barley). Disturbed areas.
Leptochloa fascicularis (Lam.) A. Gray (bearded spangletop). Prairie.
Muhlenbergia sp Schreb. (muhly). Disturbed areas.
Panicum capillare L. var. capillare (common witchgrass). Prairie, disturbed areas.
Panicum dichotomiflorum Michx. (fall panicum). Prairie, disturbed areas.
Panicum virgatum L. (switchgrass). Prairie.
Poa annua L. (annual bluegrass). Prairie.
Schedonnardus paniculatus (Nutt.) Trel. (tumblegrass). Disturbed areas.
Setaria glauca (L.) Beauv. (yellow foxtail). Disturbed areas.
Setaria viridis (L.) Beauv. (green foxtail). Disturbed areas.
Sorghastrum nutans (L.) Nash (Indian grass). Prairie.
Sorghum halepense (L.) Pers. (Johnson-grass). Floodplain, disturbed areas.
Spartina pectinata Link (prairie cordgrass). Prairie streams.
Sporobolus cryptandrus (Torr.) A. Gray (sand dropseed). Sandbar.
Tripsacum dactyloides (L.) L. (eastern gammagrass). Prairie.
Triticum aestivum L. (wheat). Cultivated land.

POLYGONACEAE (Buckwheat Family)

Erigonum annuum Nutt. (annual eriogonum). Prairie edge.
Polygonum amphibium L. (water smartweed). Riverbank.
Polygonum arenastrum Jord. ex Bor. (prostrate knotweed). Prairie, disturbed areas.
Polygonum bicorne Raf. (pink smartweed). Prairie, riverbank.
Polygonum hydropiperoides Michx. (mild waterpepper). Wet prairie.
Polygonum lapathifolium L. (pale smartweed). Riverbank
Polygonum ramosissimum Michx. (bush knotweed). Disturbed areas.
Polygonum scandens L. (false buckwheat). Riverbank.
Rumex altissimus Wood. (pale dock). Prairie.
Rumex crispus L. (curly dock). Prairie.

RANUNCULACEAE (Buttercup Family)

Anemone caroliniana Walt. (Carolina anemone). Prairie.
Delphinium virescens (prairie larkspur). Prairie.

ROSACEAE (Rose Family)

Geum canadense Jacq. (white avens)
Prunus angustifolia Marsh. (chickasaw plum, sandhill plum). Woods, river, prairie streams.

RUBIACEAE (Madder Family)

Cephalanthus occidentalis L. (common buttonbush). Woods, river, prairie streams.
Galium aparine L. (catchweed bedstraw). Prairie/woods edge.
Hedyotis crassifolia Raf. (small bluets). Prairie.

SALICACEAE (Willow Family)

Populus deltoides Marsh. subsp.monilifera (Ait.) Eckenw. (cottonwood). River, woods.
Salix amygdaloides Anderss. (peach-leaf willow). Woods, river, prairie streams.
Salix exigua Nutt. subsp. interior (Rowlee) Cronq. (sandbar willow). River, woods.

SCROPHULARIACEAE (Figwort Family)

Lindernia dubia (L.) Penn. (falsepimpernel). Moist prairie.
Verbascum thapsus L. (common mullein).
Veronica agrestis L. (field speedwell). Disturbed areas.
Veronica arvensis L. (corn speedwell). Disturbed areas.
Veronica peregrina L. (purslane speedwell). Disturbed areas.

SIMAROUBACEAE (Quassia Family)

Ailanthus altissima (P. Mill.) Swingle (tree of heaven, smoke tree). So. fence line.

SMILACEAE (Greenbrier Family)

Smilax hispida Muhl. (bristly greenbrier). Woods, river and prairie streams.

SOLANACEAE (Nightshade Family)

Physalis longifolia Nutt. (common ground cherry). Prairie.
Solanum carolinense L. (Carolina horse nettle). Prairie, disturbed areas.
Solanum ptycanthum Dun. ex DC. (black nightshade). Prairie.
Solanum rostratum Dun. (buffalo bur, Kansas thistle). Disturbed areas.

TYPHACEAE (Cat-tail Family)

Typha latifolia L. (broad-leaved cat-tail). Stream.

ULMACEAE (Elm Faily)

Celtis occidentalis L. (hackberry). Woods, river, prairie streams.
Ulmus pumila L. (Siberian elm). Woods, river, prairie streams.

VERBENACEAE (Vervain Family)

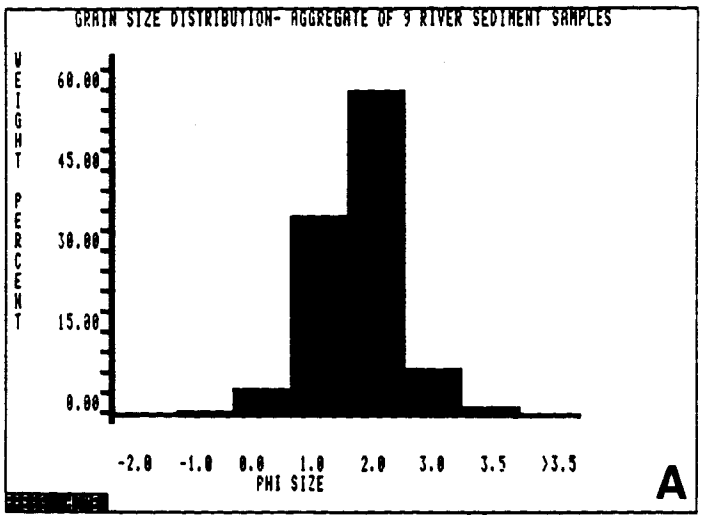
Lippia cuneifolia (Torr.) Steud. (wedgeleaf frog-fruit). Riverbank, wet woods.
Lippia lanceolata (Michx.) Greene (northern frog-fruit)

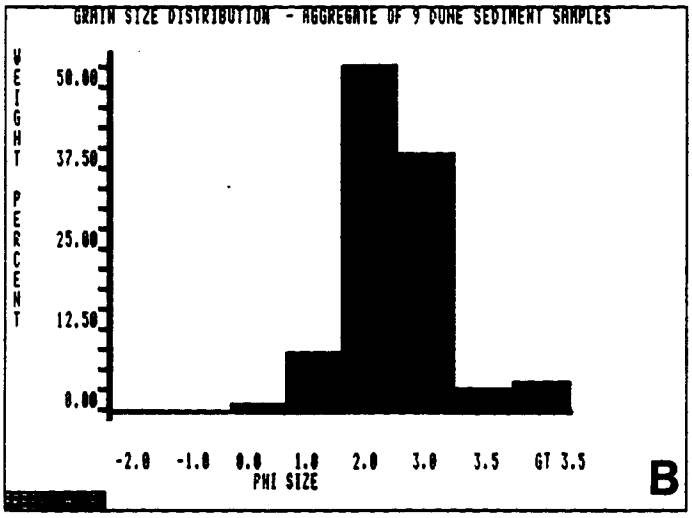
Verbena bracteata Lag. & Rodr. (prostrate verbena). Disturbed areas.
Verbena stricta Vent. (hoary verbena). Prairie.

VIOLACEAE (Violet Family)
Viola pratincola Greene (blue prairie violet). Woods.
Viola rafinesquii Greene (johnny-jump-up, wild pansy). Prairie.

VITACEAE (Grape Family)
Parthenocissus quinquefolia (L. ) Planch. (Virginia creeper). Woods, river, prairie streams.
Vitis riparia Michx. (river-bank grape). Woods, river.

ZYGOPHYLLACEAE (Caltrop Family)
Tribulus terrestris L. (puncture vine, goat head). Disturbed areas.




Grain-size analysis of sediment taken from the Ninnescah River (A) compared with samples taken from dune deposits located on the north side of the river (B). Results indicate that sand grains deposited in a fluvial (river) environment are larger and better sorted than sand deposited in an eolian (dune) environment.

$$\phi = -\log_2 S$$

Where S= size of grains in mm

(Cross, M. J., Wells, D. D. and McHenry, T. M.)

Data for Grain-Size Analysis of Sediment
from River and Dunes

| | River | | Dune | |
|---|---|---|---|---|
| Size | Weight | % | Weight | % |
| -2.0 | 0.05 | 0.0 | 0.163 | 0.0 |
| -1.0 | 2.249 | 0.5 | 0.492 | 0.0 |
| 0.0 | 19.78 | 4.0 | 3.685 | 1.0 |
| 1.0 | 155.77 | 33.0 | 42.096 | 8.0 |
| 2.0 | 251.44 | 54.0 | 256.134 | 48.0 |
| 3.0 | 34.48 | 7.5 | 189.738 | 36.0 |
| 3.5 | 4.35 | 1.0 | 18.207 | 3.0 |
| <3.5 | 1.0 | 0.0 | 23.86 | 4.0 |
| Total | 469.16 | | 534.375 | |

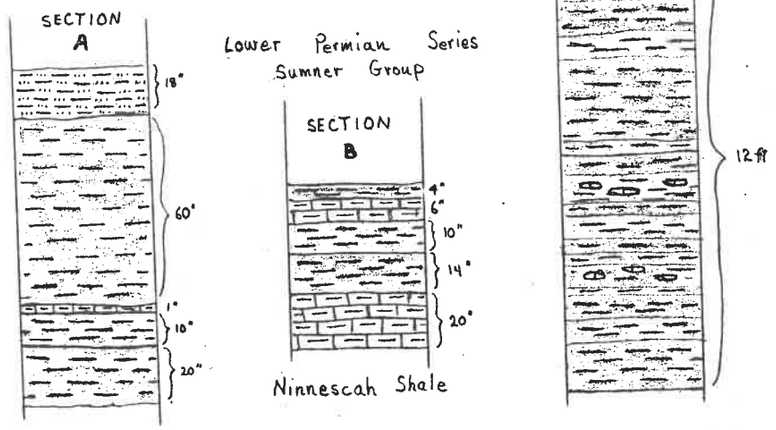
# WICHITA STATE UNIVERSITY
## NINNESCAH BIOLOGICAL RESEARCH STATION

Scale 1:3600

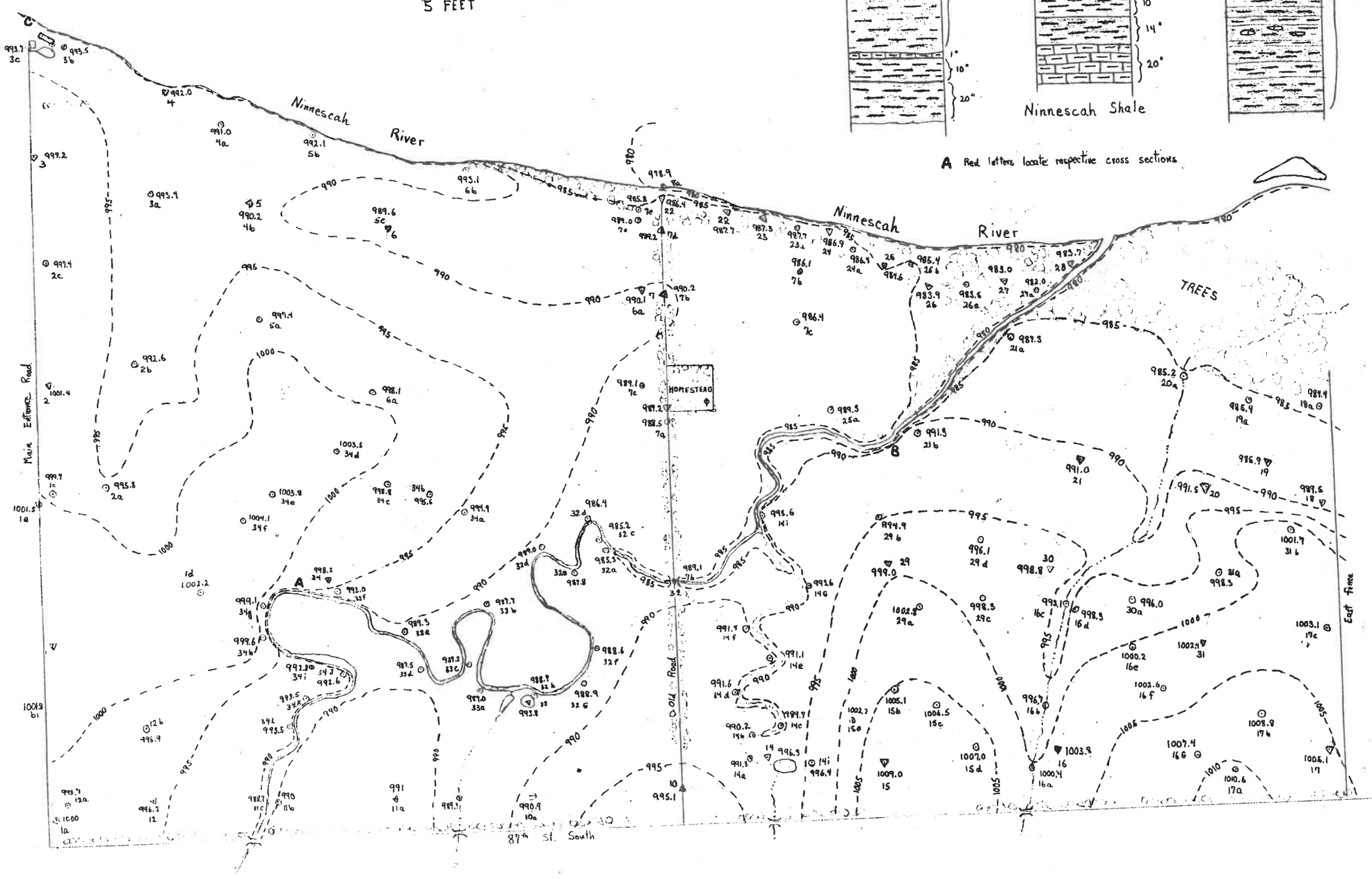
0 250 500 1000

ONE INCH EQUALS 300 FEET

CONTOUR INTERVAL
5 FEET




A Red letters locate respective cross sections





November
1987


Terry L. Roark
Jeff Klock
Richard Taylor


Horizontal Closure 25 ft
Vertical Closure 0.7 ft