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A Floristic and Ecological Study of Selected Mesic and Hydric Lowlands in Western Kansas

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A FLORISTIC AND ECOLOGICAL STUDY OF SELECTED MESIC AND HYDRIC LOWLANDS IN WESTERN KANSAS

being

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ABSTRACT

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A study was conducted in selected hydric and mesic lowland sites in Western Kansas. The objective was to collect as many as possible of the plant species present and give an ecological description of the successional units.

A total of 105 species were obtained from 10 collecting sites. The majority of the plants collected were Angiosperms. Cyperaceae and Gramineae were the largest families represented. In the annotated list families were arranged according to Gray and the Gramineae tribes according to Hitchcock.

A qualitative description was made for each community occurring in the successional units. Three units were described (flood-plain sere, spring sere, and lake sere). Several divisions were made of each sere by the differences in physiography, lifeform, and location. The final distinct community was distinguishable by the presence and homogeneity of dominant plants.

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A FLORA OF SOME SELECTED WESTERN KANSAS MESIC AND HYDRIC LOWLANDS

INTRODUCTION

This paper provides a list of mesophytic and hydrophytic plants diagnostic of the flood plain seres, spring seres, and lake seres as they occur in the lowlands of Western Kansas. All three seres result from the presence or action of water within the habitat, thus they are related by water factors within the environment.

The study of higher vascular plants associated with the above named seres provides much opportunity for research in Western Kansas. This is especially true of man-made lakes and reservoirs. These generally occur in a valley containing a river or creek with spring marshes generally present. Thus, these three units of succession can be studied vegetatively with the research areas conveniently located in the vicinity of a single lake. The flood plain and spring seres are not influenced vegetatively by their close proximity to the lake seres. The limiting factors of each seral unit differ greatly and each has its own typical vegetation.

Previous studies of the Kansas flora have been reported by Gates (1940) and Stevens (1948) and contain many of the plant types studied in this paper. These floras, however, were concerned with the entire flora of Kansas and therefore are of limited use in studying the hydrophytes and related mesophytes of Western Kansas.

Western Kansas as referred to in this paper is that part of Kansas west of State Highway 14.

COLLECTING SITES

Three major collecting sites were located at Antelope Lake, Cheyenne Bottoms, and Meade County State Park. Collections were made on other areas but were of minor importance because only a few species were taken from each one. The species were either rare or appeared to be different and collections were made for verification. Each site is discussed in more detail in the following sections.

I. ANTELOPE LAKE

Antelope Lake has been described qualitatively in the second part of this paper. Most of the plants collected here were of the lake series, others were of the spring and flood-plain series.

One species collected here and not found at the other sites was a watercress (Nasturtium officinale var. siifolium). It was a dominant of the aquatic situation in the spring s[illegible]e.

II. BARTON COUNTY LAKE

Collections were made at Barton County Lake, located five miles south and one-half mile west of Hoisington, in Barton County, for verification of certain phreatophytes. The same species were collected at Cheyenne Bottoms, three and one-half miles east of Barton County Lake.

The lake series was not well established. The phreatic situation existed as a narrow band on the lake shore and supported a sedge marsh stage. The woodland stage did not exist and only the submerged

stage of the aquatic situation was present.

III. BETHEL'S PONDS

Three ponds, referred to in Graham County as Bethel's Ponds, are located four miles south of Hill City along US Highway 283. They were spring fed and the pond water was very clear. Vegetative production was high and the ponds have often been "choked" with aquatic hydrophytes.

The pond series was well established but on a much smaller scale than the lake series. Only a few phreatophytes were collected for verification and no new species found.

One species which was very abundant in the submerged stage, but not a higher vascular plant, was stonewort (Chara). It also occurred at other sites but not nearly as abundantly.

IV. CHEYENNE BOTTOMS

Cheyenne Bottoms Wildlife Refuge is located five miles south and three miles east of Hoisington, in Barton County. The refuge is a state and federal project. It comprises one of the largest wildlife refuges in the United States and is 18,710 acres in size. Twenty-three miles of dikes create five lakes or pools. The major source of inlet water comes from the Arkansas River through a 10-mile series of canals and concrete conduits.

Cheyenne Bottoms is largely an aquatic habitat and consists of standing and running water. Running water is generally found only in

the inlet canal or intermittently in other tributaries and the outlet canal. Pool one occupies about 3,300 acres and is maintained at a depth of three to four feet. Wind has great influence upon pool one and the vegetation is mainly the more sturdy emergent anchored hydrophytes.

Pools two, three, four, and five had a varying depth of water during the year. Water was generally drained after the hunting season to allow vegetation to become established. Wave action was lessened in the pools by vegetation and shallow water. Water depth ranged from a few inches to about two and one-half feet. Borrow ditches along the edge of the dikes were deeper, often being three to six feet deep, and remained filled after the pools were drained. Many hydrophytes, both aquatic and phreatophytes, occupied the edges of the borrow ditches, small bodies of water left standing on the pool bed, and the phreatic situation (exposed pool beds). Mesophytes occupied the higher parts of the dikes; those more characteristic of prairie communities were not collected for this paper.

V. EDWARDS COUNTY

Two acres were collected in Edwards County because of the occurrence of two species which were not common at the other collecting sites. One species(pepperwort, Marsilea mucronata) was collected in Belpre along a water filled roadside ditch. Another species (Cyperus schweinitzii) was collected one mile north of Belpre in the phreatic situation of a precipitation marsh. The marsh was in

the bottom of a swale in a choppy sands area.

VI. KRAUS GOLDEN VALLEY FARM

Vegetation of a spring marsh and perennial creek was collected at Kraus Golden Valley Farm located ten miles south, and five miles west of Hays, in Ellis County. The species taken here were collected early in the study and several were later found in other areas. Two species, however, were found only here; one species (monkeyflower, Mimulus glabratus var. fremontii) existed in the aquatic situation of the spring marsh and the other species (Cursed crowfoot, Ranunculus sceleratus) occurred in shallow water of the creek.

VII. KIOWA COUNTY

One collection area was in Kiowa County one mile north of Haviland. The area was a water filled contour depression which was mainly an aquatic habitat.

Two species collected here that were not common at other sites were pepperwort and slender arrowhead (Sagittaria latifolia Forma gracilis). Other species collected were of common occurrence in other areas.

VIII. MEADE COUNTY STATE PARK

Meade County State Park is located seven miles south and five miles west of Meade and just north of Meade County Lake. The park is a project of the State Fish and Game Commission. Collecting areas

were several fish hatching ponds which have not been in use for the past three or four years and some of which have been drained.

The drained ponds supported many phreatophytes on the mucky bottoms kept wet by a stream flowing through them. The most distinctive species was Cyperus erthrorhizos which was very abundant and completely dominated some of the drained pond bottoms. A lush growth of mesophytes occurred on the drier margins.

One of the ponds still filled was pond number one which served as a reservoir to fill the others. It had a well developed pond series and contained the greater number of species at this site. One distinctive species found here was wolffia (Wolffia columbiana). It occurred in water along the pond margin.

Another area where collections were made was a spring marsh at the head of a creek flowing through the park. A rarely occurring species taken here was water pimpernel (Samolus parviflorus).

All other species collected at this site were of more common occurrence.

IX. MOORE'S PONDS

Moore's Ponds are located nine miles south and six miles west of Hays, in Ellis County. The ponds are spring fed and contain many aquatic species. A large marsh area north of the ponds is composed of a sedge marsh type of vegetation and many phreatophytes occur there.

The species collected at this site were taken for verification and no new species were found.

ANNOTATED LIST

An annotated list of plants collected on mesic and hydric lowlands of Western Kansas is given below. Annotations include characteristics of the habitat, collection locality and life form. Vouchers, or herbarium specimens, for each species are included in the author's personal herbarium and the Fort Hays Kansas State College herbarium of Cheyenne Bottoms plants which the author has identified. Both herbaria have been donated to the Elam Bartholomew Herbarium of the college. When a species was included in both herbaria the college voucher was annotated first followed by an annotation of the author's voucher. The collection locality is indicated by symbols. Symbols of locality and terminology used for life form are explained as follows:

Symbol	Locality
AL	Antelope Lake
BCL	Barton County Lake
BP	Bethel's Ponds
CB	Cheyenne Bottoms (Author's voucher)
(CB)	Cheyenne Bottoms (College voucher)
EC	Edwards County
GVF	Kraus Golden Valley Farm
KC	Kiowa County
MCSP	Meade County State Park
MP	Moore's Ponds

Life Form

Hydrophytes
- Aquatic (Species growing in area covered by water)
  - Floating hydrophyte (emersed)
  - Suspended hydrophyte (immersed)
  - Submerged anchored hydrophyte
  - Floating-leaved anchored hydrophyte
  - Emergent anchored hydrophyte
- Phreatic (Species with roots in ground water, i.e., zone of saturation)

Mesophytes (Species growing in mesic habitat and part of a primary succession)

The five groups of aquatic hydrophytes have been used according to Daubenmire's (1959) morphoecological subdivision of hydrophytes. Phreatophytes and mesophytes were also mentioned by Daubenmire but not subdivided into morphoecologic groups.

Species determinations were made by the author using Gray's Manual (1950) and Rydberg's Flora (1932) for all but the grasses which were identified with Hitchcock's Manual (1950).

Families were arranged according to Gray and the Gramineae tribes according to Hitchcock.

Species of each family were listed in alphabetical order. Common names were mainly taken from Anderson (1961) and those not included in his list from Gray or Rydberg. The common names of some species were not found in any of the available sources.

DIVISION I. PTERIDOPHYTA

Class ARTICULATAE

Family EQUISETACEAE (Horsetail Family)

Equisetum laevigatum A. Br. Smooth Horsetail.
Moist clay soil; open, sunny; creek bank. MP. Phreatophyte.

Class FILICINAE

Family MARSILEACEAE (Marsilea Family)

Marsilea mucronata A. Br. Pepperwort.
Mucky soil; shallow, calm or running water; open, sunny; edge of pond, roadside ditch. EC, KC. Floating-leaved anchored hydrophyte.

Family SALVINIACEAE (Salvinia Family)

Azolla caroliniana Willd. Water-fern.
Calm water; open, sunny; edge of large pools and along water filled ditches. (CB) Floating hydrophyte.

DIVISION II. SPERMATOPHYTA

SUBDIVISION ANGIOSPERMAE

Class MONOCOTYLEDONEAE

Family TYPHACEAE (Cattail Family)

Typha angustifolia L. Narrow-leaf Cattail.
Wet lowland and shallow water; pool 1. (CB). Emergent anchored hydrophyte--phreatophyte.

Typha latifolia L. Common Cattail.
Wet lowland and shallow water; pool 1 (CB). Mucky soil; shallow water; open, sunny; reed marsh, lake shore. AL. Emergent anchored hydrophyte--phreatophyte.

Family SPARGANIACEAE (Bur-reed Family)

Sparganium eurycarpum Engelm. Giant Burreed.
Shallow water; pool 2 (CB). Emergent anchored hydrophyte.

Family NAJADACEAE (Naiad Family)

Najas guadalupensis (Spreng.) Magnus Southern naiad.
Quiet, shallow, slightly turbid water; submerged stage of lake. AL. Suspended hydrophyte.

Family ALISMATACEAE (Water-plantain Family)

Sagittaria latifolia Willd. Common Arrowhead.
Shallow water; pool 4. (CB). Mucky soil; shallow water; open, sunny; reed marsh of lake, spring marsh. AL, MCSP. Emergent anchored hydrophyte.

Sagittaria latifolia Forma gracilis (Pursh) Robins. Slender Arrowhead.
Mucky soil; shallow water; open, sunny; in reed marsh stage of pond. KC. Emergent anchored hydrophyte.

Family GRAMINEAE (Grass Family)

Tribe FESTUCEAE

Poa glaucifolia Scribn. and Will.
Moist heavy soil at base of dike. (CB). Phreatophyte--Mesophyte.

Distichlis stricta (Torr.) Rydb. Inland Saltgrass.
Moist heavy soil; lowland along outlet stream; pool 1. Base of dike at pool 2. (CB). Phreatophyte--Mesophyte.

Tribe HORDEAE

Hordeum jubatum L. Foxtail Barley.
Moist alluvial soil; shade; woodland floor. AL. Mesophyte.

Hordeum pusillum Nutt. Little Barley.
Moist heavy soil; base of dike; pool 4. (CB). Mesophyte.

Tribe AVENEAE

Sphenopholis obtusata (Michx.) Scribn. Prairie Wedgegrass.
Wet or moist, mucky alluvial soil; shade; marshy area at edge of lake woodland. AL. Phreatophyte--Mesophyte.

Tribe AGROSTIDEAE

Muhlenbergia frondosa (Poir.) Fernald. Wirestem Muhly.
Moist, sandy or mucky alluvial soil; open, sunny; grass meadow on lake margin, weedy drained pond bottom. AL, MCSP. Mesophyte.

Tribe CHLORIDEAE

Leptochloa fascicularis (Lam.) A. Gray. Bearded Sprangletop.
Moist, heavy soil; lowland; pool 4 (CB). Mesophyte.

Spartina pectinata Link. Prairie Cordgrass. (Slough Grass)
Wet heavy soil at base of dike. (CB). Wet, mucky or heavy soil; open, sunny; seeping water, spring marsh. MCSP. Phreatophyte.

Tribe PHALARIDEAE

Phalaris arundinacea L. Reed Canarygrass.
Wet to moist, alluvial soil; open, sunny; edge of pool. CB. Phreatophyte.

Tribe ORYZEAE

Leersia oryzoides (L.) Swartz. Rice Cutgrass.
Wet, mucky alluvial soil; open, sunny; boggy-marsh, exposed lake bed. AL. Phreatophyte.

Tribe PANICEAE

Eriochloa contracta Hitchc. Prairie Cupgrass.
Wet, heavy soil at base of dike; pool 4. (CB). Phreatophyte.

Echinochloa colonum (L.) Link. Jungle Rice.
Wet, heavy soil at base of dike; pool 1. (CB). Phreatophyte.

Echinochloa crusgalli (L.) Beauv. Barnyard Grass.
Wet, heavy soil; lowland. (CB). Phreatophyte--Mesophyte.

Echinochloa crusgalli var. frumentaceae (Roxb.) W. F. Wight. Japanese Millet.
Wet, heavy soil at base of dike; edge of pool. (CB). Phreatophyte--Mesophyte.

Echinochloa crusgalli var. mitis (Pursh) Petern. Barnyard Grass.
Moist, alluvial soil; shade; woodland floor, exposed lake bed. AL. Phreatophyte--Mesophyte.

Family CYPERACEAE (Sedge Family)

Carex brevior (Dew.) Mackenz.
Moist, heavy soil at base of dike. (CB). Mesophyte.

Carex emoryi Dew. Emory Sedge.
Wet, mucky soil; open, sunny; spring marsh. AL. Phreatophyte.

Carex gravida Bailey. Heavy Sedge.
Moist, alluvial soil; open, sunny; grass meadows or sedge meadow. GVF. Phreatophyte--Mesophyte.

Carex hystricina Muhl. Bottle-brush Sedge.
Wet, heavy or mucky alluvial soil; open, sunny; sedge marsh, exposed lake bed. AL, MCSP. Phreatophyte.

Carex lanuginosa Michx. Woolly Sedge.
Wet, mucky alluvial soil; shade or open, sunny; sedge marsh of spring and exposed lake bed. AL. Phreatophyte.

Carex stricta Lam. Niggerhead.
Moist, saline alluvial soil; shade; flood plain, bank of creek. BCL. Phreatophyte--Mesophyte.

Carex vulpinoidea Michx. Fox Sedge.
Moist or wet, heavy or mucky alluvial soil; open, sunny; sedge marsh, exposed lake bed. AL. Phreatophyte.

Cyperus erythrorhizos Muhl.
Moist, heavy alluvial soil; open, sunny; weedy drained pond bottom. MCSP. Mesophyte.

Cyperus ferruginescens Boeckl.
Wet lowland; pool 4 (CB). Wet to moist, mucky alluvial soil; shade or open, sunny; spring marsh, sedge marsh of lake, occasionally reed marsh. AL, MCSP. Phreatophyte.

Cyperus filiculmis Vahl. Fern Flatsedge.
Moist heavy soil at base of dike; pool 4 (CB). Mesophyte.

Cyperus inflexus Muhl.
Wet heavy soil; edge of pool 4. (CB). Wet, sandy or mucky soil; open, sunny; sand or silt bars in creek bed. AL, MCSP. Phreatophyte.

Cyperus rivularis Kunth.
Wet, sandy or mucky alluvial soil; open, sunny; sand bars in creek bed, mud flats on pond margin. MCSP. Phreatophyte.

Cyperus schweinitzii Torr.
Moist, sandy soil; open, sunny; grassy sedge marsh, a precipitation marsh. EC. Phreatophyte--Mesophyte.

Eleocharis macrostachya Britt.
Shallow water and wet lowland; pool 3 (CB). Wet, mucky alluvial soil; open, sunny; sedge marsh, alluvial bar in lake. AL. Emergent anchored hydrophyte--Phreatophyte.

Eleocharis parvula var. anachaeta (Torr.) Svenson.
Moist or wet, mucky alluvial soil; shade or open, sunny; sedge marsh, exposed lake bed, and weedy meadow, drained pond bottom. AL, MCSP. Phreatophyte.

Fuirena simplex Vahl. Umbrella Grass.
Wet, mucky soil; shade; seeping water in springy creek bed and sedge marsh of pond. MCSP. Phreatophyte.

Scirpus acutus Muhl. Hard-stem Bulrush.
Alluvial soil; shallow water; open, sunny; reed marsh of pond. MCSP. Emergent anchored hydrophyte.

Scirpus americanus Pers. American Bulrush
Heavy soil; shallow water; pool 4. (CB). Moist or wet, mucky alluvial soil; open, sunny; sedge marsh, exposed lake and pond bed. AL, MCSP. Emergent anchored hydrophyte--Phreatophyte.

Scirpus heterochaetus Chase. Slender Bulrush.
Heavy soil; shallow water; pool 3. (CB). Mucky soil; shallow water; reed marsh of lake. AL. Emergent anchored hydrophyte.

Scirpus pallidus (Britt.) Fern. Pale Bulrush.
Wet, mucky alluvial or sandy mucky soil; open, sunny; sedge marsh of alluvial bar and pond margin. AL, BP. Phreatophyte.

Scirpus paludosus Nels. Alkali Bulrush.
Heavy soil; shallow water; pool 4. (CB). Wet, mucky soil to shallow water; open, sunny; reed- and sedge marsh, lake margin. BCL. Emergent anchored hydrophyte--Phreatophyte.

Scirpus validus Vahl. Softstem Bulrush.
Heavy soil; shallow water; pool 4. (CB). Emergent anchored hydrophyte.

Family LEMNACEAE (Duckweed Family)

Lemna minor L. Common Duckweed.
Shallow water, pond edge; floating stage at edge of reed marsh. MCSP. Floating hydrophyte.

Spirodela polyrhiza (l.) Schleid. Water Flaxseed.
Slightly turbid shallow water; open, sunny; lake edge, in reed marsh and submerged stage. AL. Floating hydrophyte.

Wolffia columbiana Karst. Wolffia.
Suspended at surface of shallow, quiet water; open, sunny; pond edge, in reed marsh and submerged stage. MCSP. Suspended hydrophyte.

Family PONTEDERIACEAE (Pickerelweed Family)

Heteranthera limosa (SW.) Willd. Mudplantain.
Heavy soil; lowland; shallow water. (CB). Emergent anchored hydrophyte.

Family JUNCACEAE (Rush Family)

Juncus kansanus F. J. Herm. Kansas Rush.
Wet, mucky alluvial soil; open, sunny; weedy sedge marsh, alluvial bar in lake. AL. Phreatophyte.

Juncus torreyi Coville. Torry Rush.
Moist or wet, mucky alluvial soil; open, sunny; weedy sedge marsh or sedge marsh; alluvial bar in lake, pond margin, and spring marsh. AL, GVF, MCSP. Phreatophyte.

Class DICOTYLEDONEAE

Family SALICACEAE (Willow Family)

Salix amygdaloides Anders. Peach-leaved willow.
Moist to wet, loamy or mucky alluvial soil; open, sunny; boggy marsh and woodland of lake, alluvial bar. AL. Phreatophyte--Mesophyte.

Salix interior Rowlee. Sand-bar willow.
Moist to wet, alluvial or sandy muck soil; high water table; open, sunny; weedy sedge marsh, alluvial bar. AL. Phreatophyte.

Family URTICACEAE (Nettle Family)

Boehmeria cylindrica (L.) Sw. Bog-hemp.
Wet, mucky alluvial soil; open, sunny; boggy marsh, exposed lake bed. AL. Phreatophyte.

Urtica procera Muhl. Tall Nettle.
Wet, mucky alluvial soil; open, sunny; boggy marsh, exposed lake bed. AL. Phreatophyte.

Family POLYGONACEAE (Buckwheat Family)

Polygonum aviculare var. littorale (Link) W. D. T. Koch. Prostrate Knotweed.
Heavy, moist to wet soil; base of dike. (CB). Phreatophyte -- Mesophyte.

Polygonum coccineum Muhl. Swamp Smartweed.
Wet heavy soil at base of dike; pool 4. (CB). Shallow water or wet, mucky alluvial soil; open, sunny; reed marsh and boggy marsh, exposed lake bed. AL, BCL. Emergent anchored hydrophyte--Phreatophyte.

Polygonum lapathifolium L. Curltop Smartweed.
Wet heavy soil at base of dike; pool 4. (CB). Wet mucky alluvial soil or shallow water; open, sunny; boggy marsh on exposed lake bed, spring marsh, and creek bed. AL, GVF, MCSP. Emergent anchored hydrophyte--Phreatophyte.

Polygonum longistylum Small. Longstyle Smartweed.
Wet heavy soil at base of dike. (CB). Moist alluvial soil; open, sunny; creek bank, floodplain. CB. Phreatophyte--Mesophyte.

Polygonum pensylvanicum L. Pennsylvania Smartweed.
Wet, mucky alluvial soil; open, sunny; boggy marsh, alluvial bar and exposed lake bed. AL. Phreatophyte.

Polygonum persicaria L. Ladysthumb Smartweed.
Moist alluvial soil or mucky alluvial soil; shade or open, sunny; woodland floor and weedy drained pond bottom. GVF, MCSP. Mesophyte.

Rumex altissimus Wood. Pale Dock.
Moist heavy soil at base of dike. (CB). Wet, mucky alluvial soil; open, sunny; boggy marsh, alluvial bar. AL. Phreatophyte--Mesophyte.

Family CERATOPHYLLACEAE (Hornwort Family)

Ceratophyllum demersum L. Hornwort.
Quiet, shallow, slightly turbid water; submerged stage of lake. AL. Suspended hydrophyte.

Family RANUNCULACEAE (Crowfoot Family)

Ranunculus sceleratus L. Cursed Crowfoot.
Mucky, spring creek bed; shallow water; open, sunny. GVF. Emergent anchored hydrophyte.

Family CAPPARIDACEAE (Caper Family)

Polanisia trachysperma T. & G. Roughseed Clammyweed.
Moist sandy lowland; pool 4 (CB). Moist, sandy soil; open, sunny; broad creek bed and flood plain. MP. Phreatophyte--Mesophyte.

Family CRUCIFERAE (Mustard Family)

Iodanthus pinnatifidus (Michx) Steud. Purplerocket.
Wet, mucky alluvial soil; open, sunny; boggy marsh, exposed lake bed. AL. Phreatophyte.

Nasturtium officinale R. Br. True Watercress.
Sandy creek bed; shallow slow running water; shade. AL. Floating-leaved anchored hydrophyte.

Nasturtium officinale var. siifolium (Reichenb.) Koch.
Mucky soil; shallow water, slow flowing; spring marsh. AL. Floating-leaved anchored hydrophyte.

Rorippa sinuata (Nutt.) Hitchc. Yellow Cress.
Wet heavy soil at base of dike. (CB). Phreatophyte--Mesophyte.

Family LEGUMINOSAE (Purse Family)

Amorpha fruticosa Coult. Indigobush Amorpha.
Moist, alluvial or sandy alluvial soil; shade or open, sunny; creek bank and woodland, edge of lake. AL, MP. Phreatophyte.

Desmanthus illinoensis (Michx.) MacM. Illinois Bundleflower.
Wet heavy soil; lowland. (CB). Phreatophyte.

Desmanthus leptolobus T. & G. Slenderlobed Bundleflower.
Wet heavy soil at base of dike; pools 1 and 4. (CB). Phreatophyte.

Glycyrrhiza lepidota (Nutt.) Pursh. American Licorice.
Moist heavy soil in bottom of road ditch near canal. (CB). Mesophyte.

Family EUPHORBIACEAE (Spurge Family)

Euphorbia serpens HBK. Serpent Euphorbia.
Wet heavy soil at base of dike. (CB). Phreatophyte--Mesophyte.

Family VITACEAE (Vine Family)

Parthenocissus quinquefolia (L.) Planch. Virginia Creeper.
Moist, alluvial soil; shade; on peach-leaved willow, lake woodland. AL. Mesophyte.

Vitis vulpina L. Fox-Grape.
Moist, alluvial soil; shade; on peach-leaved willow, lake woodland and flood plain woodland. AL. Mesophyte.

Family ELATINACEAE (Waterwort Family)

Bergia texana (Hook.) Seubert. Texas Bergia.
Moist, mucky alluvial soil; open, sunny; drained pond bottom. MCSP. Phreatophyte.

Family TAMARICACEAE (Tamarisk Family)

Tamarix gallica L. French Tamarisk. (Salt cedar)
Wet heavy soil at base of dike; pool 1. (CB). Phreatophyte--Mesophyte.

Family LYTHRACEAE (Loosestrife Family)

Ammannia auriculata Willd. Earleaf Ammannia.
Moist to wet, mucky alluvial soil; open, sunny; weedy drained pond bottom. MCSP. Phreatophyte--Mesophyte.

Ammannia coccinea Rothb. Purple Ammannia.
Wet heavy soil; lowland; pool 4. (CB). Wet to moist, mucky or sandy alluvial soil or shallow water; open, sunny; weedy creek bank and drained pond bottom, reed marsh of pond and lake. AL, KC, MCSP. Emergent anchored hydrophyte--Phreatophyte.

Lythrum alatum Pursh. Winged Lythrum.
Wet heavy soil at base of dike; edge of water. (CB). Phreatophyte.

Rotala ramosior (L.) Koehne. Rotala.
Wet, mucky alluvial soil; shade; sedge marsh, exposed lake bed. AL. Phreatophyte.

Family UMBELLIFERAE (Parsley Family)

Berula erecta (Huds.) Coville. Water Parsnip.
Mucky, springy creek bed; shallow water; open, sunny. MCSP. Emergent anchored hydrophyte.

Family PRIMULACEAE (Primrose Family)

Samolus parviflorus Raf. Water Pimpernel.
Sandy muck soil; oozing water; shade; springy creek bed. MCSP. Phreatophyte.

Family APOCYNACEAE (Dogbane Family)

Apocynum cannabinum L. Indian Hemp.
Moist heavy soil; creek bank, inlet canal. (CB). Mesophyte.

Family ASCLEPIADACEAE (Milkweed Family)

Asclepias incarnata L. Swamp Milkweed.
Wet, mucky or sandy alluvial soil; open, sunny; spring marsh and sedge marsh of pond. AL, BP. Phreatophyte.

Family CONVOLVOLACEAE (Convolvulus Family)

Convolvulus sepium L. Hedge Bindweed.
Moist, sandy alluvial soil; open, sunny; weed stage of flood plain. AL. Mesophyte.

Family BORAGINACEAE (Borage Family)

Heliotropium curassavicum L. Seaside Heliotrope.
Wet heavy soil; lowland; pool 4. (CB). Phreatophyte.

Family VERBENACEAE (Vervain Family)

Lippia lanceolata Michx. Fog-Fruit.
Moist to wet, mucky alluvial soil; open, sunny; weedy drained pond bottom, sedge meadow of lake. BCL, MCSP. Phreatophyte.

Verbena hastata L. Blue Vervain.
Moist to wet, mucky alluvial soil; open, sunny; creek bank, weed stage of floodplain, weedy sedge marsh on alluvial bar. AL. Phreatophyte--Mesophyte.

Family LABIATAE (Mint Family)

Lycopus americanus Muhl. American Bugleweed.
Wet, mucky alluvial soil; open, sunny; boggy marsh, exposed lake bed, reed marsh of pond. AL, MCSP. Phreatophyte.

Nepeta cataria L. Catnip.
Moist, sandy loam soil; open, sunny; weedy flood plain. AL. Mesophyte.

Scutellaria lateriflora L. Mad-dog Skullcap.
Wet, mucky soil; open, sunny; boggy marsh, exposed lake bed. AL. Phreatophyte.

Family SCROPHULARIACEAE (Figwort Family)

Bacopa rotundifolia (Michx.) Wettst. Roundleaf Macuillamia.
Shallow water over lowland. (CB). Shallow water; floating stage of lake. AL. Floating hydrophyte.

Mimulus glabratus var. fremontii (Benth) Grant. Monkeyflower.
Mucky soil; shallow running water; open, sunny; spring marsh. GVF. Emergent anchored hydrophyte.

Mimulus glabratus var. michiganensis (Pennell) Fassett. Monkeyflower.
Mucky soil; shallow running water; open, sunny; spring marsh. AL, MCSP. Emergent anchored hydrophyte.

Veronica peregrina L. Purslane Speedwell.
Moist heavy soil at base of dike. (CB). Mesophyte.

Family LENTIBULARIACEAE (Bladderwort Family)

Utricularia vulgaris L. Common Bladderwort.
Water three to four feet deep; pool 4. (CB). Suspended hydrophyte.

Family CAMPANULACEAE (Bluebell Family)

Lobelia siphilitica L. Great Lobelia.
Wet, mucky alluvial soil; open, sunny; weedy sedge marsh, exposed lake bed. AL. Phreatophyte.

Family COMPOSITAE (Composite Family)

Ambrosia trifida L. Giant Ragweed.
Moist heavy soil; lowland; end of outlet canal. (CB). Mesophyte.

Aster exilis Ell.
Wet heavy soil at base of dike. (CB). Phreatophyte.

Aster nemoralis Forma albiflorus Fern. Bog Aster.
Wet, mucky alluvial soil; open, sunny; boggy marsh, exposed lake bed. AL. Phreatophyte.

Bidens cernua L. Nodding Beggarticks.
Wet, mucky or sandy alluvial soil; shade or open, sunny; sedge marsh of pond, muddy shore or lake. AL, BP. Phreatophyte.

Bidens tripartita L. Bur-Beggarticks.
Wet, mucky alluvial soil; shade or open, sunny; sedge marsh of pond, muddy lake shore. AL, BP. Phreatophyte.

Coreopsis tinctoria Nutt. Plains Coreopsis.
Wet heavy soil; lowland; pool 4. (CB). Phreatophyte.

Eclipta alba (L.) Hassk. Yerba-de-Tago.
Wet heavy soil; lowland. (CB). Moist, mucky alluvial soil; open, sunny; weedy drained pond bottom. MCSP. Phreatophyte--Mesophyte.

TABULAR INVENTORY

Summary by Division and Classes

Number of Plants by:	Families	Genera	Species
Pteridophyta	3	3	3
Spermatophyta	32	66	102
Angiospermae	32	66	102
Monocotyledoneae	8	24	48
Dicotyledoneae	24	42	54

Complete Summary of Species:

Pteridophyta	3
Spermatophyta	102
Total Species	105

Summary by Large Families:
(Comparative Standing)

Cyperaceae	22
Gramineae	15
Polygonaceae	7
Compositae	7
Cruciferae	4
Leguminosae	4
Lythraceae	4
Scrophulariaceae	4

Summary by Life Form:

Hydrophytes	97
Aquatic hydrophytes	28
Phreatophytes	69
Mesophytes	36
Species with double classification	28

PLANT SUCCESSION ON MESIC AND HYDRIC LOWLANDS AT ANTELOPE LAKE

INTRODUCTION

Many hydroseres occur in Western Kansas, the pioneer stage of each being either in a stream, lake, pond, or spring. A brief qualitative description of the lake and spring hydrosere is given in this paper. Flood plains along streams flowing into the lake are also described, but not classed as hydroseres.

Descriptions are restricted to the Antelope Lake area and may not be completely characteristic of other hydroseres in Western Kansas. Antelope Lake has undergone much change in appearance especially in the last few years. Most of these changes and the resulting vegetation types have been unpredictable. It may be better, therefore, to have detailed studies of individual lake areas rather than a single ecological description of all hydroseres in Western Kansas. Such studies of individual lakes could be used in the future for comparative studies, thus showing the dynamics of succession.

Antelope Lake is located in Graham County, Kansas, approximately two and one-half miles west and one-half mile north of Morland, or 14 miles west and one-half mile north of Hill City. The main part of the lake is located in the NE$\frac{1}{4}$ of Section 9, Township 8 South, Range 25 West. It is about 85 acres in size.

Antelope Lake is typical of the majority of lakes in Western Kansas in that it has "silted in" to a great extent and mechanical failure of the dam has occurred; both events resulting in the exposure of a large part of the lake bed. Mechanical failure is probably the greatest single factor causing final destruction of many man-made lakes

in Western Kansas. With the improvement of farming methods and the reseeding of severely eroded fields in recent years "silting in" of lakes has been greatly reduced. Although dredging of lakes to increase depth is an unprofitable venture it would seem that the State could very well reclaim many of the lakes by repairing the mechanical faults, i.e. holes in dam sites and spillways. Such repair would provide increased "wildlife" habitats and recreational areas.

Further studies of our lakes are needed to better understand their ecology, find ways of reclaiming those that are destroyed, and ways to preserve those that are still existing.

METHODS AND MATERIALS

Plant communities were classed according to descriptions given in Weaver and Clements (1938) with some revision of terminology by the author. Communities were distinguished according to their appearance and location.

Several literature sources were used in giving a general description of the area. History of the Antelope Lake area was found scattered through files of the County Commissioners at the Graham County Court House. Geography and geology material was taken from various geology papers and bulletins cited, as well as from other papers available at the County Seat.[1] Many site description terms were taken from the AGI Glossary (1957).

Plant communities have been discussed as they occurred during the period of study, the summers of 1961 and 1962. The study area was first divided into three major seres (flood-plain series, spring series, lake series) according to the physiographic nature of the site. Further division varied with the major type of sere. The flood-plain series was divided first into groups of communities according to the life form of the vegetation and later into distinct communities characterized by presence and homogeneity of dominant species. The spring and lake series were first divided into groups of communities according to the water

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[1] U. S. Weather Bureau Data and County Temperature Reports at the Hill City Airport; Agricultural Reports in the Extension Office at the County Court House.

DESCRIPTION OF THE AREA

I. HISTORY

Funds were made available from the Kansas Emergency Relief Committee and the Water Conservation Transfer Receipt for the establishment of the Recreational Lake on Antelope Creek. Work on the dam was accomplished by the Works Progress Administration. Total expenditure for construction of the lake was $64,702.85, according to the County Commissioners' final report. It was turned over to Graham County, completed and approved, on June 8, 1935 and has since been referred to as Antelope Lake.

II. GEOGRAPHY OF GRAHAM COUNTY

Graham County is entirely in the High Plains section of the Great Plains physiographic province (Adams, 1903). The area does not consist of flat gently rolling upland plains typical of the High Plains farther west (Frye, 1945 and Prescott, 1954) but rather is moderately to well dissected. Most of the county is well drained and sloping ground predominates. The most extensive areas of flat land are on the terrace surface that is located in the valley of South Fork Solomon River. The lowest point in the county, which is where South Fork Solomon River enters Rooks County, is about 1,900 feet above sea level. Several places on the west side of the county have altitudes of more than 2,600 feet, with a maximum altitude record of 2,633 feet (Prescott, 1955). Thus the maximum relief is more than 700 feet.

South Fork Solomon River is the principal stream in Graham County. It flows across the center of the County from west to east and drains about two-thirds of the area (Prescott, 1955). The tributaries to this river are ephemeral -- that is, they flow only during and after periods of heavy rain. However, parts of some of the tributaries are spring-fed and maintain a small perennial flow.

The climate of Graham County is subhumid and is characterized by abundant sunshine, moderate precipitation, and a high rate of evaporation. During the summer the days are hot but the nights are generally cool. The summer heat is alleviated by good wind movement and low relative humidity. Winters are moderate with only occasional short periods of severe cold and with relatively light snowfall. The normal monthly mean temperature recorded at the Hill City Airport is 53.9°F. The highest normal monthly mean temperature is 79.0°F. in July and lowest normal monthly mean temperature is 28.5°F in January. The average length of growing season is 165 days but extremes of from 128 to 196 days have occurred.

The normal annual precipitation at Hill City as determined by the U. S. Weather Bureau is 20.55 inches. A low of 9.65 inches in 1910 and a high of 39.38 inches in 1941 were reported. About 77 per cent of the precipitation falls during the growing season from April through September when moisture is needed most by the vegetation.

Agriculture is the principal occupation in Graham County, which, according to a census of the State Board of Agriculture in 1945, had 909 farms. In 1950, 192,824 acres of crops were harvested, approximately

70 per cent of the crop land being devoted to the raising of wheat. About 40 per cent of the land is in pasture and cattle raising is, therefore, a major occupation.

III. GEOLOGY OF GRAHAM COUNTY

Prescott (1955) has given a complete and comprehensive report in the geology and ground-water resources of the county. The following material has been taken from his report.

> The outcropping rocks in Graham County are sedimentary and range from late Cretaceous to Recent in age. The oldest outcropping rock is the Smoky Hill chalk member of the Niobrara formation, which underlies the entire county. The Ogallala formation of Tertiary (Pliocene) age overlies the Smoky Hill chalk member, but in several areas erosion has removed the Ogallala and the Cretaceous bedrock is exposed. Along many of the valleys where the Ogallala has been removed, late Wisconsinan terrace deposits mantle the bedrock. Other older Pleistocene alluvial deposits are the Crete sand and gravel member of the Sanborn formation and the Meade formation. The wind-blown silt of the Sanborn constitutes the surficial material over much of the area, particularly in the uplands. The youngest deposits are Recent alluvium along the streams and scattered sand dunes.
>
> The Ogallala formation is the most wide-spread water-bearing formation in the county and yields water to many wells. In stream valleys the late Wisconsinan terrace deposits supply water to many wells and also the Crete yields water to wells. Small amounts of water can be obtained from the Niobrara formation, and from the upper part of the Carlile shale, which underlies the Niobrara. The Dakota formation, which underlies the surface at depths ranging from about 500 to 1,100 feet, contains considerable amounts of water. However, this water is of questionable quality.
>
> The body of ground water contained in the Pleistocene and Pliocene deposits is recharged principally by precipitation that falls in the county or in adjacent areas to the west. Groundwater recharge to the Niobrara formation probably takes place in a similar manner. Some recharge to the Carlile and Dakota formations may result from local precipitation but probably the greater part of recharge to these aquifers takes place in their areas of

outcrop. Ground water is discharged from Pleistocene deposits through transpiration and evaporation, by discharge into streams, by subsurface movement into other areas, and by wells and springs. Discharge from Cretaceous aquifers is accomplished principally through subsurface movement.

SITE DESCRIPTION

The main body of water of Antelope Lake covers a broad flat at the junction of two valleys. The dam is located where the valley narrows beyond the junction and from the dam Antelope Creek drains into South Fork Solomon Valley. Both valleys above the lake contain perennial creeks, one being Antelope Creek and the other an unnamed tributary.

The types of lowlands studied were: flood plains and lake margin of the valley flats; some draw bottoms of each valley system; exposed lake bed, and a levee delta at the mouth of Antelope Creek. The latter two areas are unique in that they are of recent formation. A brief history of each will be discussed.

1. Exposed Lake Bed

Extensive cultivation has resulted in considerable erosion in the lake basin. This erosion has been intensified due to the deep loess parent material which is more erodable than many other materials. As a result the lake has been "silted in" and the depth greatly reduced. Silting, however, has not been the only factor contributing to the exposure of certain areas. During the early 1950's much flooding occurred and a gully formed in the spillway (Fig. 1) lowering the water level about two feet. Nearly four acres of the lake bed was exposed (Fig. 2). Further eroding of the spillway has been impeded by a shale

Figure 1. Gully in spillway at Antelope Lake, Graham County, Kansas.

- - - Old original shore line

_____ Water level in 1955

Figure 2. Aerial photograph of Antelope Lake area taken in 1955. Antelope Creek entering from left and unnamed tributary at top of photograph. Antelope Lake, Graham County, Kansas.

formation underlying it. The water level has been relatively stable since at least 1955 (Compare Figs. 2 and 3).

2. Levee Delta

The bed of a channel which extended some distance along Antelope Creek was also exposed when the water level dropped. As the creek cut its way down through the channel bed it left silt deposits at the mouth. As the deposits accumulated a spit was formed parallel to the flow of the creek reaching out into the lake. With increasing effect of floods the spit was raised higher above the water surface and extended further into the lake forming a natural levee delta. This levee delta was formed and exposed during the period from 1955 to 1961 (Fig. 3).

- - - Old original shore line

_____ Water level in 1961

Figure 3. Aerial photograph of Antelope Lake area taken in 1961. Antelope Creek entering at left and unnamed tributary at top of photograph. Antelope Lake, Graham County, Kansas.

DISCUSSION OF COMMUNITIES

The flood-plain series will be discussed first followed by the spring and lake series. The former series is a mesic habitat and the latter two are "hydric." Each description is qualitative and concerned mainly with the vegetation of the community. Brief descriptions of the physical environment are also given.

I. FLOOD-PLAIN SERIES

Flood-plain seres occurred along both creeks draining into the lake. Both seres were nearly identical and have been discussed as a single unit. This unit of succession consisted of two associes; one with one community and the other with two distinct communities. Each community will be discussed in order of its distance from the creek bank.

1. Weedy Associes

A single weedy associes occupied an area most disturbed by flooding on top of the creek bank. Open areas within the woodland also supported this community. Generally, along the creek banks it was very narrow but, in the study area along Antelope Creek it was much wider. A greater width occurred here because the area was formerly the bed of a lake channel which extended a considerable distance along the creek.

Dominant plants were giant ragweed (Ambrosia trifida), blue vervain (Verbena hastata), and wirestem muhly (Muhlenbergia frondosa).

The former two species were about 15 feet tall and densely populated along the creek bank while in the open areas of the woodland blue vervain disappeared and giant ragweed was somewhat shorter and more thinly populated. Wire stem muhly formed dense patches scattered throughout the area disappearing completely where the other two dominants were abundant.

Other species were: hedge bindweed (Convolvulus sepium), catnip (Nepeta cataria), and sandbar willow (Salix interior). The weedy associes was the pioneer stage of the flood-plain series. Early in the spring, floods washed the dead vegetation away leaving the ground surface nearly bare, but new lush growth soon began and the rapid growing weedy species dominated the area. Floods, occurring during the growing season, flattened the vegetation (Fig. 4) but it soon became upright and few plants were destroyed.

2. Woodland Associes

Two distinct communities comprised the woodland associes. Adjacent to the weedy associes on the creek bank was a peach-leaved willow (Salix amygdaloides) consocies and beyond this was a plains cottonwood (Populus sargentii) consocies. Both consocies were about the same width and were separated by an open area which supported a weedy associes. Both consocies of the woodland had a similar type of understory and other woody species were scattered throughout. Little vegetation was present under both woodland consocies, but did include the following species: giant ragweed, wirestem muhly, hedge bindweed, catchweed bedstraw (Galium aparine),

Figure 4. Weed associes of flood plain after heavy flooding. Taken along Antelope Creek near Antelope Lake, Graham County, Kansas.

aster (Aster praelatus), and Indian hemp (Apocynum cannabinum). Other woody species were: green ash (Fraxinus pennsylvanica), black mulberry (Morus nigra), common hackberry (Celtis occidentalis), box elder (Acer negundo), honey locust (Gleditsia triacanthos), Virginia creeper (Parthenocissus quinquefolia), fox grape (Vitis vulpina), and poison ivy (Rhus radicans).

The canopy was dense and produced nearly complete shade. Litter was not abundant on the woodland floor, but floods had piled considerable brush around the bases of the trees. The flood plain was level and had a moist, silty alluvial soil of loessial origin.

II. SPRING SERIES

Most of the spring marshes in the study area were located in the bottoms of draws or on slopes and were well drained (Figs. 5 and 6). Communities of such areas appeared the same and were divided into two groups according to amount of water present.

1. Aquatic Situation

A portion of the spring area was covered with water, usually a gently flowing stream. Aquatic hydrophytes were very abundant forming a solid mat, thus composing the aquatic-marsh stage. Floating-leaved and emergent anchored types grew intermixed and not as distinct stages as found in the lake series. Much vegetation had accumulated and the substratum was a thick layer of peat over sandy muck soil.

Dominants were true watercress (Nasturtium officinale), watercress

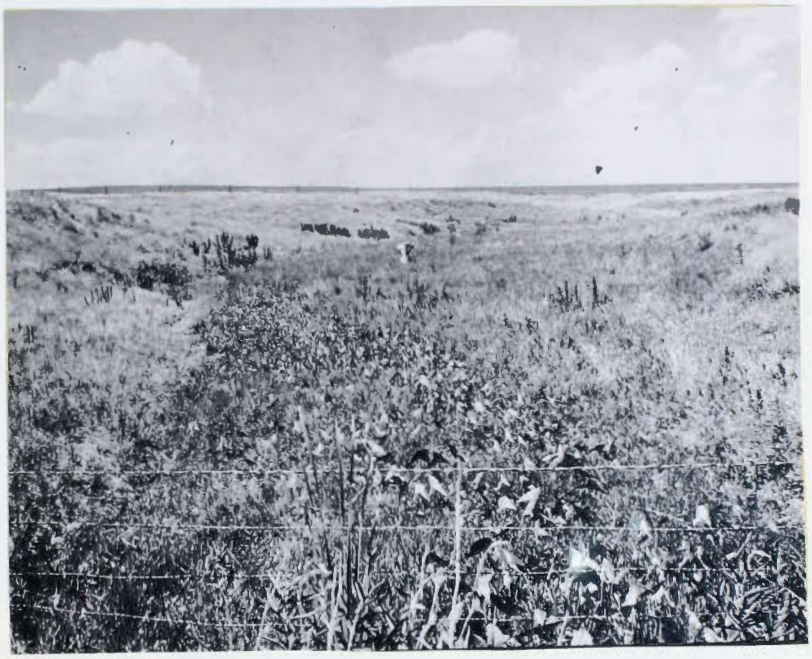

Figure 5. Well drained spring marsh in draw bottom near Antelope Lake, Graham County, Kansas.

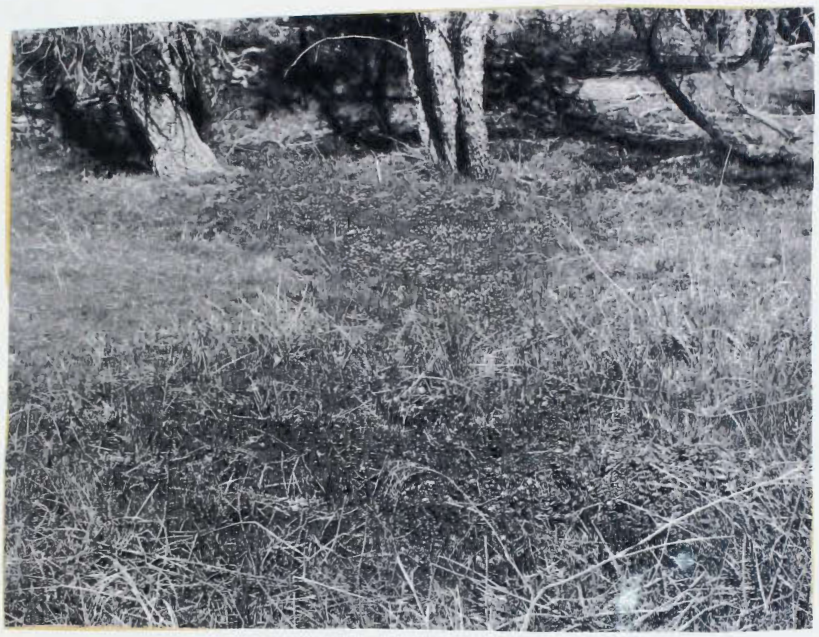

Figure 6. Well drained spring marsh on a slope near Antelope Lake, Graham County, Kansas.

(Nasturtium officinale var. siifolium), water parsnip (Berula erecta), and monkeyflower (Mimulus glabratus var. michiganensis). Common arrowhead (Sagittaria latifolia) also occurred showing local dominance.

2. Phreatic Situation

Outside the standing water or flowing stream was a very wet area where spring seepage occurred below the ground surface. Phreatic hydrophytes, or phreatophytes, were very abundant and made up the sedge-marsh stage. A thin layer of peat was present and the soil below was heavy muck.

Dominants were woolly sedge (Carex lanuginosa), American bulrush (Scirpus americanus), and spikesedge (Eleocharis). Inland saltgrass (Distichlis stricta) was dominant only on the outer edges of the community. Bottlebrush sedge (Carex hystricina) was abundant but occurred only on hummocks and in small clumps throughout the area. Emory sedge (Carex emoryi) also showed local dominance forming large open beds.

Other species present were mainly swamp milkweed (Asclepias incarnata) and American bugleweed (Lycopus americanus).

Two other types of spring series were present in the research area but their exact nature was not clear. One was a moderately well drained area which had communities similar to those described above. Some of the major differences were that it had a much deeper peat layer, over one foot thick, and the phreatic situation had an abundant cover of rice cutgrass (Leersia oryzoides) along with sedges and rushes.

It could be classed as a "boggy" sedge-marsh (Fig. 7). Another spring sere was poorly drained and had only the phreatic situation. The water table was almost at the surface of a heavy muck soil. This different type of sere had a very striking appearance with its single dominant, rice cutgrass. Other species present were mainly common cattail (Typha latifolia) and swamp milkweed. This area could be classed as a "boggy" marsh (Fig. 8).

III. LAKE SERIES

Three major divisions were made of the lake sere. Communities occurring in water formed the aquatic situation, those on very wet soil formed the phreatic situation, and the final communities with a mesic habitat formed the mesic situation (Fig. 9). The former two situations contained hydrophytes and the latter supported mesophytes. Each community will be discussed in successional order beginning with the pioneer stage.

1. Aquatic Situation

Submerged-marsh stage. The pioneer stage was in slightly turbid water up to a foot in depth, covering a soft mucky lake bed of alluviated loess. Due to the loessial nature of material washed in, the main body of water was almost neutral; slightly acid conditions existed in the submerged stage. Submerged anchored, floating, and suspended hydrophytes were present and very dense (Fig. 10).

Figure 7. "Boggy" sedge-marsh stage on the phreatic situation of a moderately well drained spring marsh. Antelope Lake, Graham County, Kansas.

Figure 8. "Boggy"-marsh stage on the phreatic situation of a poorly drained spring marsh. Antelope Lake, Graham County, Kansas.

Figure 9. View of lake series showing aquatic situation, phreatic situation, and mesic situation. Stages easily visible are: reed-marsh, "boggy"-marsh, and woodland. Antelope Lake, Graham County, Kansas.

Figure 10. Submerged stage of lake series. Antelope Lake, Graham County, Kansas.

Dominants were pondweeds (Potamogeton spp.), hornwort (Ceratophyllum demersum), and southern naiad (Najas guadalupensis). Water flaxseed (Spirodela polyrhiza), a floating hydrophyte, also occurred but its distribution was controlled by wind and water currents and occurred in all aquatic communities.

Floating-marsh stage. The floating-marsh stage was not too prominent. It existed only in small open areas next to patches of bulrush consocies and small coves in the reed marsh stage along the shore. The areas were protected from wind and wave action and the water was only about six inches deep. Longleaf pondweed (Potamogeton nodosus) completely dominated the floating marsh stage. The floating leaves formed a solid mat on the water surface not only in the main part of the community but also among the bulrushes and cattails surrounding the area.

Reed-marsh stage. Four consocies were present in the reed marsh stage.

The largest community was the broad leaf arrowhead (Sagittaria latifolia) consocies which occurred in areas protected from wind and wave action (Fig. 11). Water was up to one foot deep in the inner edge of the community and often only one inch deep on the outer edge. A few of the submerged stage species were present in this community occurring only along the inner edge.

Bordering the arrowhead consocies on the outer edge and along the open shore was a common cattail consocies (Fig. 11). It existed

Figure 11. Broadleaf arrowhead consocies in foreground bordered by common cattail consocies across center of picture, reed-marsh stage of lake series. "Boggy"-marsh is between cattails and woodland in background. Antelope Lake, Graham County, Kansas.

as a narrow band in water up to five inches deep.

A softstem bulrush (Scirpus validus)consocies was present in water up to a foot in depth and exposed to wind and wave action. The community occurred as large patches surrounded by open water or as wide areas along the shore (Fig. 12). "Relict" areas of this consocies occurred in the phreatic situation (exposed lake bed) along the original shore line. The "relict" areas were slowly being replaced by the "boggy" marsh and woodland stages.

Slender bulrush (Scirpus heterochaetus) formed a consocies in water up to a foot in depth. It appeared about the same as the common bulrush consocies except that it only occurred as large patches in open water away from the shore (Fig. 13).

2. Phreatic Situation

Sedge-marsh stage. During the summer of 1961 small areas of the sedge-marsh stage occurred along shores next to the reed-marsh stage. The same areas in 1962, however, supported the "boggy"-marsh stage and only a few species from the previous year still existed. Communities observed in 1961 were spikesedge (Eleocharis) consocies along sandy shores; American bulrush (Scirpus americanus) consocies and spikesedge (Eleocharis parvula var. anachaeta) consocies both on mud flats back of the shore line.

Other species present among the American bulrush consocies were: Kansas rush (Juncus kansanus), Torry rush (Juncus torreyi), and woolly sedge (Carex lanuginosa).

Figure 12. Softstem bulrush consocies in reed-marsh stage of lake series, left half of photograph along shore, Antelope Lake, Graham County, Kansas.

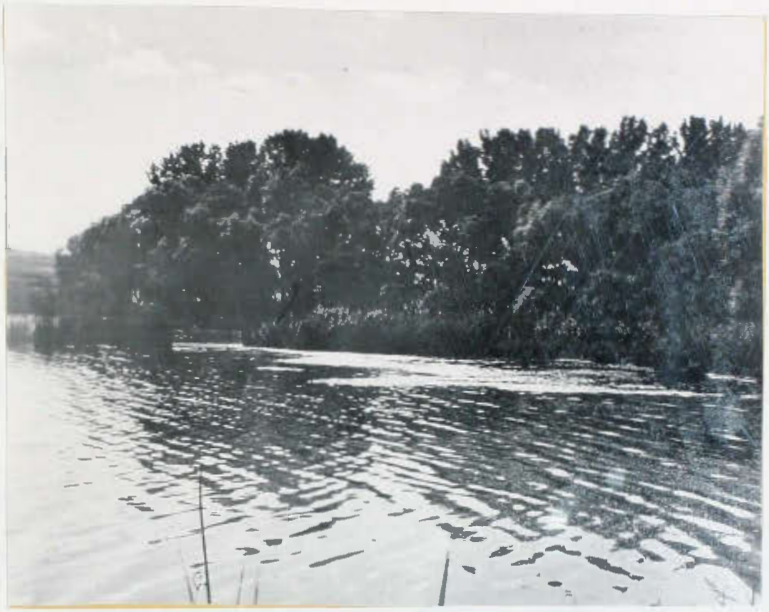

Figure 13. Patches of slender bulrush consocies, reed-marsh stage of lake series. Antelope Lake, Graham County, Kansas.

"Boggy"-marsh stage. A "boggy" condition occurred on both the exposed lake bed and levee delta. Boggy conditions resulted from an accumulation of vegetative material and lack of drainage. Decomposition of the vegetative material has been slow as indicated by a layer of peat over the saturated mucky soil and by high acidity. The neutral nature of the loessial alluvium has probably contributed to the attainment of the high acidity, not having limy materials to counteract it. Both areas supporting this community were only raised a few inches above the lake water level and kept saturated by influent seepage from the lake. During early spring and later, following rains, the exposed lake bed and much of the levee delta were inundated. Drainage was slow and the soil surface never became dry.

The "boggy" marsh community contained the greatest number of species, several of which formed distinct socies (Figs. 14 and 15). Swamp milkweed (Asclepias incarnata), bur-beggarticks (Bidens tripartita), and curlytop smartweed (Polygonum lapathifolium) were very abundant and formed definite socies. Though many species were present only rice cutgrass was dominant (Fig. 16). Common cattails were very abundant and showed local dominance but probably occurred as "relicts" of the reed-marsh stage.

Due to the large number of species present they will be tabulated as follows:

Dominant:	
Leersia oryzoides	Rice cutgrass

Figure 14. Curlytop smartweed socies at bottom of photograh and swamp milkweed socies above. Antelope Lake, Graham County, Kansas.

Figure 15. Bur-beggarticks socies at bottom of photograph and "relict" cattail consocies above. Antelope Lake, Graham County, Kansas.

Figure 16. Close-up of rice cutgrass consocies in the "boggy" marsh stage of the lake series. Antelope Lake, Graham County, Kansas.

Abundant species:	
Asclepias incarnata	Swamp milkweed
Bidens tripartita	Bur-beggarticks
Polygonum lapathifolium	Curlytop smartweed
Other species:	
Juncus kansanus	Kansas rush
Juncus torreyi	Torrey rush
Scirpus pallidus	Pale bulrush
Cyperus ferruginescens	
Carex vulpinoidea	Fox sedge
Carex lanuginosa	Woolly sedge
Carex hystricina	Bottle-brush sedge
Echinochloa crusgalli var. mitis	Barnyard grass
Sphenopholis obtusata	Prairie wedgegrass
Urtica procera	Tall nettle
Boehmeria cylindrica	Bog-hemp
Polygonum coccineum	Swamp smartweed
Polygonum pensylvanicum	Pennsylvania smartweed
Rumex altissimus	Pale dock
Iodanthus pinnatifidus	Purplerocket
Ammannia coccinea	Purple ammannia
Rotala ramosior	Rotala
Verbena hastata	Blue vervain
Lycopus americanus	American bugleweed
Scutellaria lateriflora	Mad-dog skullcap
Lobelia siphilitica var. ludoviciana	Great lobelia
Bidens cernua	Nodding beggarticks
Aster nemoralis Forma albiflorus	Bog aster
Woody invaders:	
Salix amygdaloides	Peach-leaved willow
Salix interior	Sand-bar willow

The term "boggy" marsh has been used to name this stage of succession because the area is definitely part of the lake marsh and has bog conditions (peat layer, high water content, and high acidity). The term was first coined by Jantzen (1960) describing a similar area in Stafford County. Jantzen stated that this type of community was not too common in Western Kansas, but evidence in the present paper indicates that it is more common than he surmised.

3. Mesic Situation

Woodland stage. The woodland community was a peach-leaved willow consocies on the outer edge of the lake series (Figs. 9 and 17). The soil was moist and covered with an inch or more of litter. Understory species were not abundant and occurred mainly in the older part of the woodland where trees were taller and not as dense. Younger trees on the inner edge were very dense and catchweed bedstraw was about the only understory species there.

Other species of the understory were:

Woody species:	
Amorpha fruticosa	Indigobush amorpha
Parthenocissus quinquefolia	Virginia creeper
Rhus radicans	Poison ivy
Vitis vulpina	Fox grape
Herbaceous species:	
Hordeum jubatum	Fox-tail barley
Sphenopholis obtusata	Prairie wedgegrass
Echinochloa crusgalli var. mitis	Barnyard grass
Polygonum persicaria	Ladysthumb smartweed
Pepo foetidissima	Buffalogourd
Nepeta cataria	Catnip
Croton texensis	Texas croton

Climax stage. The community described here was not of the lake sere proper but of lowland sites in relict grassland areas adjacent to the lake. The soil was deep alluvium of loessial origin and had good moisture content. A big bluestem (Andropogon gerardi Vitman), switchgrass (Panicum virgatum L.), Indiangrass (Sorphastrum nutans (L.) Nash), faciation composed the climax stage. Cover was very high and a deep mulch occurred. No other significant species were present.

Figure 17. Peach-leaved willow consocies which composed the woodland stage of the lake series. Antelope Lake, Graham County, Kansas.

SUMMARY

A qualitative description was made of each community occurring in the flood plain series, spring series, and lake series at Antelope Lake, Graham County, Kansas. Dominants of the community were named, other species listed, and some of the more important habitat factors discussed.

The flood plain sere consisted of two stages, a weedy associes and woodland associes. The former stage was composed of one distinct community, giant ragweed-blue vervain-wirestem muhly associes, and the latter of two communities, peach-leaved willow consocies and plains cottonwood consocies.

The spring sere had two types of communities, one type was present in the aquatic situation and another type in the phreatic situation. Only one community, the aquatic marsh stage, was found in the aquatic situation (true watercress-watercress-water parsnip-monkey-flower associes). One community, the sedge-marsh stage was most prominent in the phreatic situation being a woolly sedge-American bulrush-spikesedge associes. Two other kinds of spring seres existed in the research area but were not well understood. Enough evidence was present, however, to show that at least three kinds of spring seres occur, characterized by differences in communities of the phreatic situation. The three kinds of spring series in the phreatic situation were sedge marsh (well drained), "boggy" sedge marsh (moderately well drained), and "boggy" marsh (poorly drained).

Three groups of communities composed the lake series occurring either in the aquatic situation, phreatic situation or mesic situation. The aquatic situation contained three stages of succession. First the submerged-marsh stage characterized by an associes of pondweeds, hornwort, and southern naiad; second the floating-marsh stage which was not too prominent but distinguishable by a longleaf pondweed associes; and third a reed-marsh stage composed of four consocies listed as follows: broad leaf arrowhead consocies, common cattail consocies, softstem bulrush consocies, and slender bulrush consocies.

The phreatic situation of the lake series contained two stages. A sedge-marsh stage occurred in 1961 composed of two spikesedge consocies and an American bulrush consocies, but did not appear in 1962. The "boggy"-marsh stage was present over most of the area characterized by a rice cutgrass consocies, cattail relicts, several additional socies, and a great number of other species.

The mesic situation contained the woodland stage and climax stage. A peach-leaved willow consocies occurred as the woodland stage. The climax stage occurred in an area not part of the primary succession and was composed of a big bluestem-switchgrass-Indiangrass faciation.

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