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FLORISTIC ANALYSIS OF A NATURAL AREA ON THE LOWER PLATTE RIVER FLOOD PLAIN

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The vascular flora of an extinct river-island and inactive north-channel of the Platte River was studied from 1972-1978. Within a variety of vegetation types, including seral and subclimax flood plain forests, 289 species were identified from 200 genera and 70 families. The flora is dominated by four families, the Poaceae, Asteraceae, Cyperaceae, and Fabaceae, which contribute 40% of the species. Forty-eight species of woody plants occur in the area, including 17 species not previously reported in Dodge County. While much of the flora is composed of forest species (36.1%), significant numbers of ruderal and marsh species (each 19.4%) are also present. Riparian and prairie species each contribute 8.3%, while meadow and pond contribute 5.5% and 2.8%, respectively. High species-richness is attributed to a favorable interaction of several variables including geological events, microclimate, river regimen, disturbance, and biological events. If significant changes in the river regimen occur in the future, changes in composition of the vegetation and flora can be expected. Species richness, particularly in aquatic areas, will decrease if provisions are not made for maintaining seasonally high-flows in the Platte River.

† † †

INTRODUCTION

The islands and related flood plain environs of the lower Platte River have attracted recognition because of their high ecologic, esthetic, and recreational values (Anonymous, 1970; 1975a). Several proposals have been made for their preservation, but natural resource assessments are deficient in many respects, including those for the vegetation and flora. Previous work on the lower 163 km of the river from Columbus to the mouth has been limited to a floristic study of the early to mid-successional vegetation on two islands near Louisville (Morrison, 1935). Data on later-seral vegetation do not exist. The long-term survival of these islands and other riverine natural areas is uncertain because of lack of understanding of how they will be affected by future changes in river hydrology and hydraulics. Further channel and flood plain modification activities along the Platte River (sand-and-gravel mining, flood-protection works, bank stabilization, and residential development) can also greatly affect these islands.

Average annual-flows of the Platte River, a braided stream, have decreased over the past 70 years because of increasing water consumption upstream. Highly reduced flows in portions of the mid-Platte reach in central Nebraska have led to vegetational encroachment and siltation, reducing the channel width by more than one-half and causing islands to disappear (Williams, 1978). These phenomena are also of long-term concern in the lower Platte River, because consumptive water-usage upstream continues to grow.

The purpose of this study was to assess and evaluate the flora found on the downstream portion of a former river-island and remnant-channel areas of the Platte River near Fremont, Nebraska. This study was done in conjunction with development of a comprehensive resource-management plan for the area, sponsored by the Parks and Recreation Department, city of Fremont.

STUDY AREA

Location

The study area is found along the lower Platte River, about 91 km northwest of its confluence with the Missouri River (Fig. 1), and just south of the city of Fremont in southern Dodge County. It occupies the downstream end of an old river-island, locally known as Fremont or Big Island, and remnant north-channel areas of the Platte. In 1947, 66 ha of these lands was deeded to the city of Fremont for use as a public park. Designated as *Luther Hormel Memorial Park*, the area currently provides an attractive outdoor setting, including about 1,500 m of river frontage along the Platte River. Recreational use is varied and heavy during weekends (Becker and Lockhart, 1975, Unpublished report to the Parks and Recreation Department, city of Fremont, Nebraska).

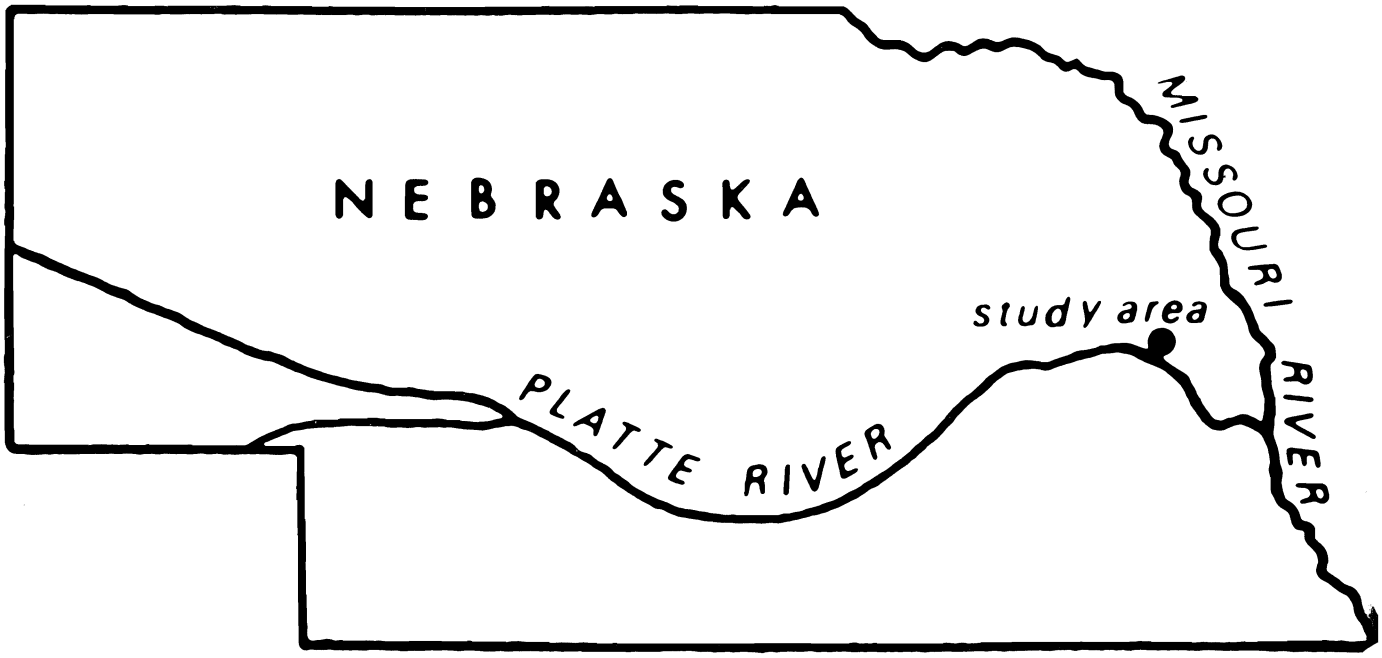

FIGURE 1. General location of the study area.

Climate

The study area is found within the tall-grass prairie region of Nebraska, an area climatically defined as moist subhumid (Thornthwaite, 1948). Average annual precipitation is less than potential evapotranspiration, and deciduous-forest development is generally restricted to lower or special topographic situations where soil moisture and other conditions are amenable. Variations in seasons are great—winters are dry and cold while summers are warm and more moist. Mean annual precipitation at Fremont is 78.6 cm over the period 1941-1970 (Anonymous, 1973), but droughts may occur in summer, and periodically they are very severe.

Physiography and Soils

The Platte River has cut a deep valley near the stu area, and high bluffs, about 40 m high, fringe the south main channel. The post-Kansan geology of the lower Plat Valley, which includes the study area, was described a interpreted by Lueninghoener (1947). Relief within the stu area is 3.7 m, somewhat greater than that found in ot flood plain areas. A natural levee, which is aligned along t east-west axis of the old river-island, is the highest and m striking physiographic feature. Other features, found along t levee flanks or elsewhere on the island, include old river-ban scour holes, and chutes. The bed of the old north chan forms a flat plain over the northern part of the area (*see* marsh area in Fig. 2). During periods of bank-full flows, which are characteristic of the river in spring, waters back up within the north channel and in other depressions on the flood plain. During floods the north channel conveys considerable floodwater despite the presence of numerous obstructions upstream.

Flooding and sedimentation have played an important part in developing the soils of the area. The soils are immature and profile development is limited to A and C layers or none at all. Maximum topsoil depth in the area approaches 30 cm, found on the natural levee. In most areas soils are complexly layered, consisting of lenses of clay, silt, and clay intermixed with buried organic layers. Soil-water relations are variable, but often are water-logged in depressions and droughty in high areas containing coarse sediments. Soils receive water through natural precipitation, overland flow, backwater, and subsurface recharge. Subsurface water levels fluctuate rapidly during the growing season, apparently related to changing river stages.

Hydrology

River discharge and stages along the study area vary widely annually and seasonally. Floods are common during the spring thaw and ice break-up period, while low flows are common during middle and late summer. Much of the study area has been flooded at least eight times since 1949 (Anonymous, 1975b; personal observations). Highest discharge at the North Bend gauging station during the 1949–1977 period of record was 3,169.6 m^3/s (112,000 cfs) in 1960; however, the highest river stage in the study area in recent times occurred in 1978 as a result of a severe ice jam. Only a few hectares near the top of the natural levee escaped flooding.

During low flows much of the river bed is exposed, and becomes dry and vegetated. The computed seven-day, 10-year low discharge for the North Bend gauging station (Anonymous, 1975b) was 11.9 m^3/s (420 cfs). No zero flows have been observed in historical times; however, a low flow of 1.02 m^3/s (36 cfs) was observed on July 29, 1974 (Anonymous, 1974).

Vegetation

A brief account of the natural vegetation of Fremont Island was provided by J. J. Hawthorne around 1900 (letter to editor, *Fremont Tribune,* Louis E. May Historical Museum, Fremont). The lower one-half was described as wooded, particularly along the south channel, and 30 species of woody plants were reported. Species specifically identified were basswood, red cedar, two species of elm, ash, oak, hackberry, red mulberry, several species of willow, cottonwood, wild grape, and Virginia creeper. Rare species were not mentioned.

Forest vegetation is now largely confined to Hormel Park, although elsewhere a few relict stands of some very large cottonwoods (*Populus deltoides*) persist. While existing forest stands resemble the flood plain forests of other reaches of the lower Platte River, they show evidence of greater maturity and age.

METHODS

In order to facilitate systematic work, major habitat and plant communities were delineated through low-altitude, color and infrared, aerial photography and confirmed by ground-level reconnaisance studies. Habitat types were then classified according to dominant vegetational or physical characteristics, and the extent of each was plotted on a suitable base map. In addition, forest types were further subdivided and mapped on the basis of dominance, estimated by percentage of crown cover.

Intensive floristic sampling in each habitat type was conducted during 1972–1978, and observations were made on life form, abundance, and dispersal mechanisms. Specimens were identified to the lowest-recognizable taxon, using the nomenclature of the Great Plains Flora Association (Anonymous, 1977) for genera and species. For higher taxa the nomenclature of Gleason and Cronquist (1967) was followed. Confirmation of identified specimens was made through the assistance of recognized specialists. Interpretation of life form was based on Raunkiaer's system (Raunkiaer, 1934), while those for dispersal type utilized criteria found in Pijl (1969) and Ridley (1930). Abundance ratings were made on the basis of ease of location within the area, distribution or areal extent, and estimate of density. Five abundance categories were used: very abundant, abundant, infrequent, rare, and very rare. A geographic classification, utilizing data available in Fernald (1950), Gleason and Cronquist (1967), and Scoggan (1957), was also made.

Field observations on site physical characteristics, especially river-flow conditions, were taken coincident with collection work or during low- or high-flow periods. Limited elevational data were available from the city of Fremont and the United States Army Corps of Engineers, Omaha District.

RESULTS AND DISCUSSION

Flora List

The natural area contains a diverse flora including 289 species of vascular plants of 200 genera and 70 families. Four families, the Poaceae, Asteraceae, Cyperaceae, and Fabaceae,

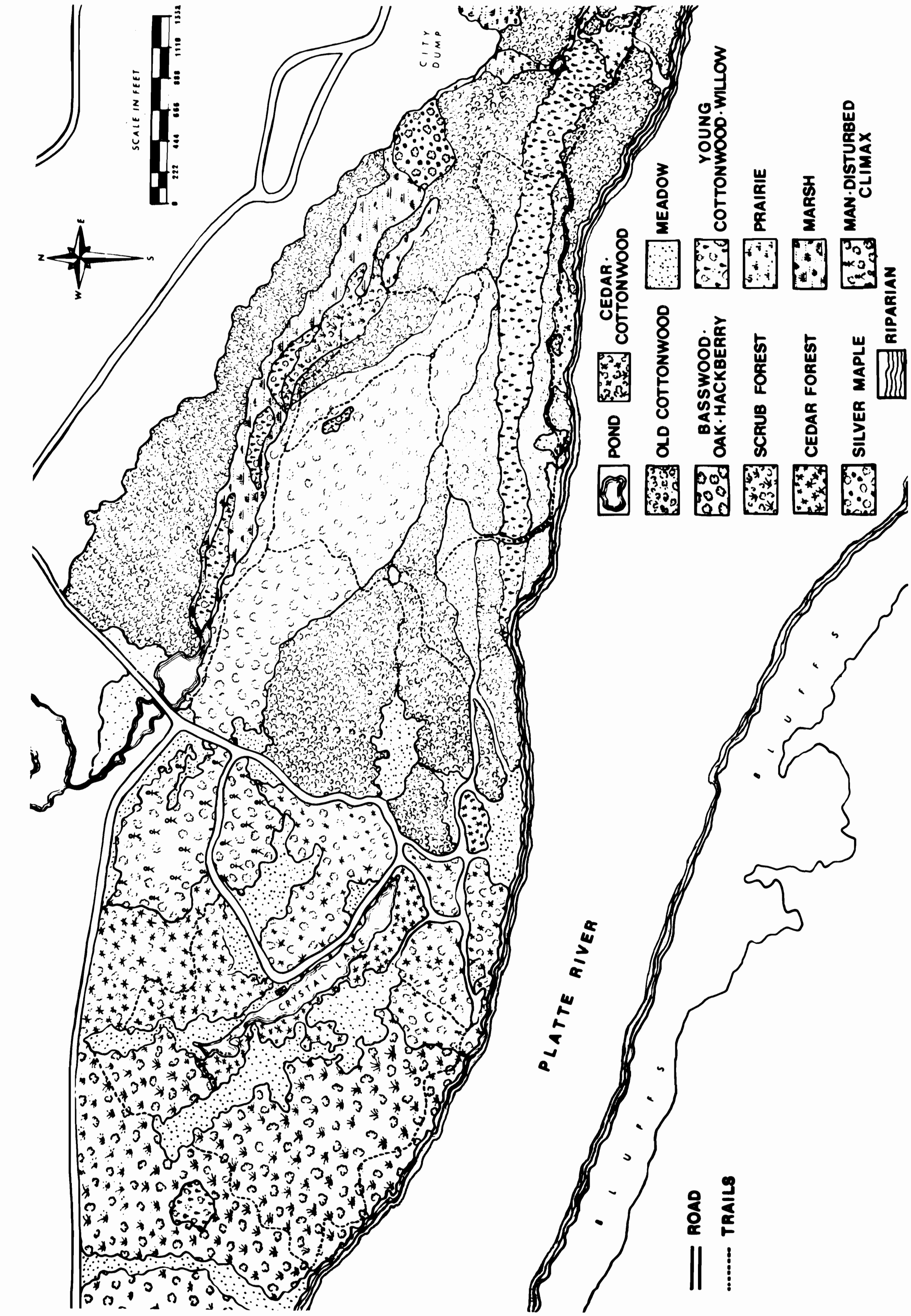

FIGURE 2. Habitats of the study area.

contribute 40% of the species (Table I). Eighty-one species are new records for Dodge County, but these include only one new record for the state (*Lysimachia nummularia*). Forty-eight species of woody plants occur, including 17 species not previously reported in the county.

TABLE I. Summary of predominant families of plants.

Family	Number of Species	Percent of Total
Poaceae	42	14.5
Asteraceae	36	12.5
Cyperaceae	21	7.3
Fabaceae	15	5.2
Lamiaceae	12	4.2
Polygonaceae	10	3.5
Rosaceae	9	3.1
Scrophulariaceae	7	2.4
Apiaceae	7	2.4
Lilaceae	6	2.1
Ranunculaceae	6	2.1
Brassicaeae	6	2.1
Euphorbiaceae	6	2.1
Salicaceae	5	1.7
Others (56)	101	34.9
Totals	289	100.1

A list of species identified is provided as an Annotated List at the conclusion of this paper. It is arranged according to Gleason and Cronquist (1967) for the vascular-plant families. Within each family, genera and species are arranged alphabetically. For each species the habitat type, dispersal mechanism, life form, and abundance rating is provided.

Ecological Characteristics of the Flora

Analysis of the flora in relationship to its habitat, life form, abundance, and dispersal mechanisms provides insight into several factors of ecological importance: spatial distribution, adaptation, rarity, and mobility. These data, discussed in detail below, can be useful in guiding future management decisions.

Habitat Types

Major habitats of the study area (Fig. 2) include forest (further subdivided into several distinct types), marsh, meadow, prairie, pond, riparian, and ruderal. The contribution of each habitat type to the entire flora of the study area is roughly proportional to the area occupied. Forest habitat contributes 36.1% to the total flora and is also dominant in areal coverage. Ruderal and marsh habitats each contributed 19.4% to the flora while riparian and prairie areas each contribute 8.3%. Meadow and pond types contribute 5.5% and 2.8%, respectively.

The distribution of the natural communities conforms to a topographic or elevational gradient. Subclimax forest, composed of *Quercus macrocarpa, Celtis occidentalis, Tilia americana,* and *Fraxinus pennsylvanica* var. *subinterrima,* forms a closed canopy along higher elevations of the natural levee, which are about 2.4 m to about 3.7 m above the river bed. Mature cottonwood and scrub forests occupy lower and more level sites, and are subject to occasional moderate flooding. The scrub forest originated in the early 1960s when Dutch Elm disease ravaged a then existing mature elm forest. The former growth is dominated by thickets of young trees (*Ulmus americana, Acer negundo, Fraxinus pennsylvanica* var. *subinterrima, Morus alba,* and *Rhamnus catharticus*), shrubs (*Cornus drummondii, Zanthoxylum americanum,* and *Ribes missouriensis*), and lianas (*Similax hispida, Toxicodendron radicans,* and *Parthenocissus quinquefolia*). Early seral cottonwood-willow stands occupy the bottoms of old scour-channels and portions of the old north channel. A stand of silver maple (*Acer saccharinum*) occupies a lower part of the latter area which is subject to one or two months of flooding during most years. Marsh or pond species, dominated by a diverse array of sedges, rushes, and grasses, are associated with depressions on the flood plain, including old scour-holes, chutes, and the old north channel. These areas are usually inundated or subject to saturated-soil conditions through most of the year. Riparian vegetation, mostly composed of prostrate or low-growing forbs and graminoids, occupies the lowest position on the elevational gradient. They dominate active channel banks or even lower portions of the main channel during low-flow periods. Distributions of ruderal and prairie vegetation, however, are less influenced by elevational gradients. Ruderal vegetation is dominated by annual or biennial forbs and annual grasses, and is found along roadsides, paths, and other heavily trampled areas. Meadows occupy areas which have been cleared for recreational purposes and are dominated by a dense cover of perennial grasses and forbs. Many of these species are escapes or introductions. Prairie vegetation is dominated by tall, native grasses and forbs and is found on undisturbed areas along the high banks of the river. Soils in these areas are coarse-textured and droughty.

The distribution of many of the natural plant communities along an elevational gradient above the river bed appears to be controlled by the frequency, duration, and intensity of flooding as documented in recent studies of Illinois flood plain communities (Bell, 1974; Bell and del Morel, 1977).

Life Forms

Life form spectrum-analyses indicate that the flora (Fig. 3) is dominated by hemicryptophytes (45.5%) and therophytes (26.2%). Phanerophytes comprise 16.6% followed by geophytes (10.7%) and chamaephytes (1.0%). This deviates considerably from Raunkiaer's (1934) normal spectrum, composed of 46.0% phanerophytes, 26.0% hemicryptophytes, 13.0% therophytes, 9.0% chamaephytes, and 6.0% geophytes. The reduced number of phanerophytes in the study area is due to greater moisture and temperature extremes (Weaver, 1960; Gleason and Cronquist, 1964). Bottomland forests along the Missouri River in central North Dakota are also dominated by hemicryptophytes (Keammerer *et al.*, 1975) and have similar percentages of phanerophytes and chamaephytes. This adaptive similarity is of interest since the Missouri River Flood Plain is 689 km to the northwest, is considerably less species-rich, and is exposed to yet greater variations in temperature and precipitation.

Abundance

Abundance ratings of the flora are summarized in Figure 3. Infrequent or rare species constitute 67% of the flora 19.0% are abundant, 5.9% are very abundant, and 8.3% are very rare. Of woody species, *Populus deltoides, Juniperus virginiana, Cornus drummondii, Symphoricarpus orbiculatus, Ribes missouriensis, Morus alba, Smilax hispida,* and *Toxicodendron radicans* are very abundant; while *Cornus amomum, Salix rigida, Viburnum lentago, Eunonymus atropurpureus, Clematis virginia,* and *Campsis radicans* are considered very rare. Among perennial, herbaceous species, *Trifolium repens, Poa pratensis, Agrostis stolonifera, Sanicula gregaria,* and *Galium aparine* are very abundant. Very rare, herbaceous species include: *Gentiana andrewsii, Spiranthes cernua, Elaeocharis obtusa, Helenium autumale, Aster novae-angliae,* and *Physostegia virginiana.*

These ratings indicate that many species are likely to be sensitive to possible future environmental changes, especially

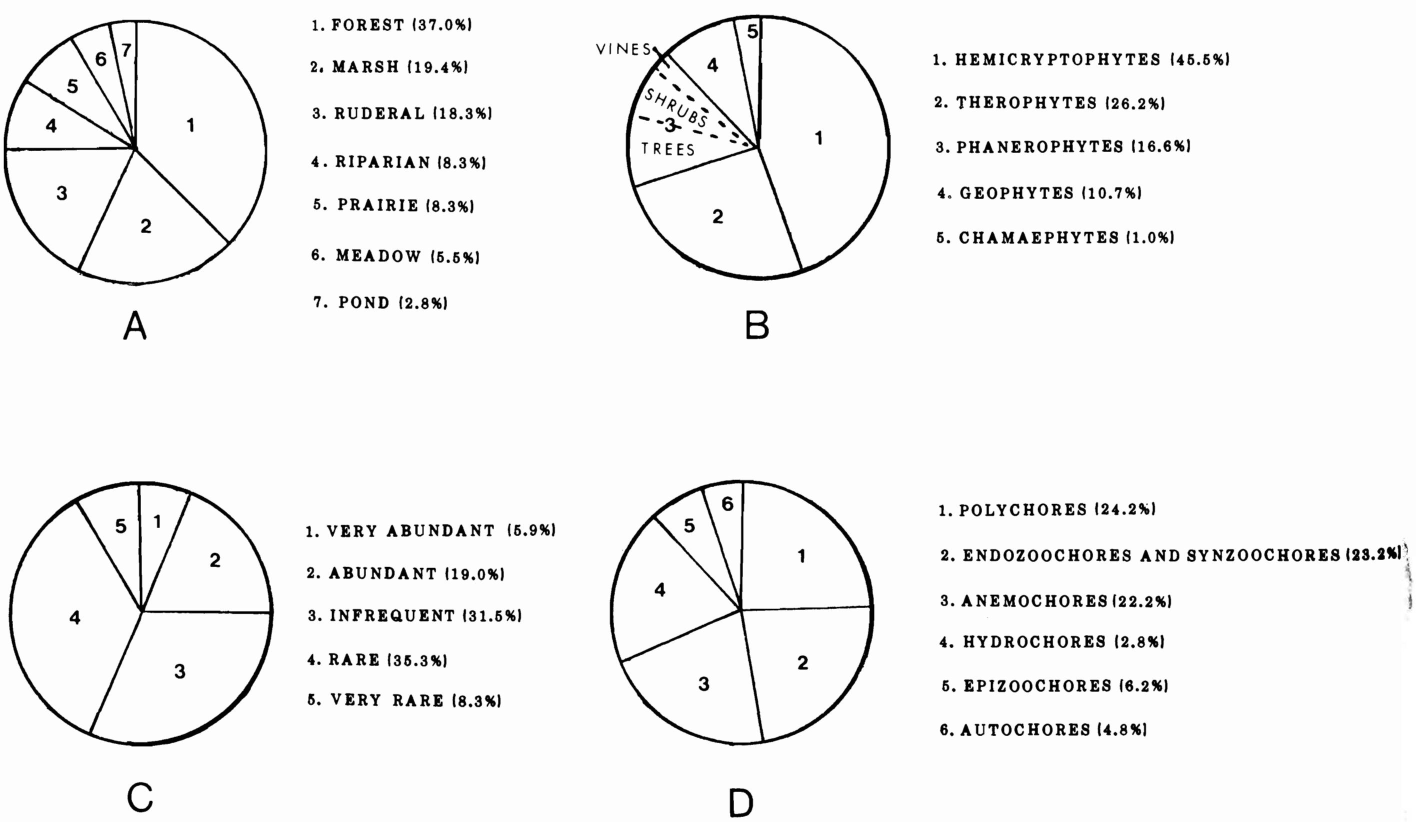

FIGURE 3. Selected ecological characteristics of the flora (%). **A.** Habitat distribution. **B.** Life form classification. **C.** Abundance ratings. **D.** Dispersal types.

very rare species. Several of these species were found at only one location in the study area. While some of these, *e.g. Eunonymus atropurpureus,* are more common in other areas along the lower Platte River, others, *e.g. Campsis radicans,* appear to be very rare.

Dispersal

In the study area, dispersal of disseminules is often accomplished by water currents during periods of flooding. Floods transport the diaspores of most species by a variety of means: (1) flotation on the water surface; (2) suspension within the water column; or (3) attachment to floating or suspended debris.

Despite the importance of flood-related dispersal, particularly long-distance, primary-dispersal mechanisms (wind, animals, and explosive mechanisms) are important during other periods; accordingly, a classification of the entire flora was attempted (Fig. 3). When compelling field evidence indicated that several agents were of significance for dispersal, however, a species was classified as polychorous. About 24.2% of the flora is considered to be of this type, including bur-fruited composites such as *Bidens cernua* and *Xanthium strumarium,* usually cited as examples of epizoochory. Both of these species exhibit spatial distributions which also indicate transport by the river during yearly flow-cycles. Other common dispersal types within the flora are transport within the bodies of animals (endozoochory and synzoochory), which includes 23.2% of the species (Fig. 3). This is closely followed by wind transport or anemochory (22.2%) and transport by water or hydrochory (19.4%). Transport on the external surfaces of animals (epizoochory) and by explosive mechanisms (autochory) is of less significance.

Dispersal of the woody-forest species occurs predominately by animals (70%) and wind (17.3%). The preponderance of animal dispersion indicates considerable forest maturity, because pioneer or early seral forests are dominated by wind-dispersed species (Pijl, 1969). Prairie species tended to rely upon anemochorous mechanisms, although several other mechanisms were also utilized. Generally, marsh, riparian, and pond species were primarily dispersed by water currents. A balanced or variety of dispersal mechanisms characterize the ruderal and meadow component of the flora.

Geographic Affinities. Examination of the modern geographic distribution of the flora of an area provides insight into its origin, dispersal power, adaptability, and resilience. A large floral component found in the study area is quite widespread latitudinally and longitudinally (118 species). Many of these are temperate species found in both the New and Old Worlds. A larger floral component, however, is restricted to North America (171 species). These are characteristic of the grasslands, the eastern deciduous forest, or the northern coniferous forest (Table II). Of all North American elements the eastern deciduous forest element is clearly dominant. The occurrence of several species with boreal affinities (*Phalaris arundinacea, Alisma subcordatum, Elaeocharis macrostachya, E. acicularis, Mentha arvensis,* and *Achillea millefolium*) is of interest; however, they are poorly represented when compared to the flood plain forest flora of the Missouri River in North Dakota (Keammerer *et al.*, 1975).

Species considered to be subcosmopolitan, or nearly world-wide in distribution, include several aquatics and terrestrial weeds. Examples of the former are *Typha latifolia, Ceratophyllum demersum, Lemna minor,* and *Spirodela polyrhiza*; those of the latter, *Digitaria sanguinalis, Taraxacum officinale, Chenopodium album,* and *Polygonum aviculare.*

Species Richness. Species richness in an area provides an indication of favorable and diverse habitat conditions for successful plant colonization and establishment. At the study site, species richness appears high. For comparison, a few surveys in Nebraska or in other Great Plains states are cited below, and information is provided on the study location, extent of study area, and numbers of species listed. These are as follows: (1) Cuming County, bordering Dodge County to the northwest, 491 species (Churchill, 1977); (2) two Platte River islands, 53 km southeast of the study site near Louisville, 147 species (Morrison, 1935); (3) a 130 km reach of the Missouri River, located far to the northwest in central North Dakota, 220 species (Keammerer *et al.,* 1975); and (4) a 322 km reach of the Red River, located far to the north in eastern North Dakota, 256 species (Wanek, 1967). Comparative data from the results of flood plain studies in other parts of Nebraska or in other states do not exist because of lack of taxonomic work, particularly for herbaceous elements. Comparisons of floristic lists of woody elements, however, can be made for flood plain sites from the prairie or eastern deciduous forest regions of the United States (Table III). This comparison indicates that species richness decreases along northerly or westerly gradients and increases along southerly or easterly ones, substantiating other findings which indicate that moisture and temperature are major factors limiting extension of deciduous forest into the grasslands of this region (Weaver, 1960; Gleason and Cronquist, 1964).

Origin of the Flora. During Medial Pleistocene time (Late Kansan to Late Illinoian) a significant geologic event led to the creation of the study area and influenced subsequent vegetational development. At that time, a small, right-bank tributary of the Elkhorn River, at a point 4.5 km upstream of the study area, captured the Platte River by headwater erosion and gradually diverted it from what is known as the Todd

TABLE II. Geographic distribution of vascular plants found in Hormel Park.

Widespread Area	Number	Restricted to North America Area	Number
Subcosmopolitan	18	Eastern Deciduous Forest	116
Northern Hemisphere	37	Prairie	47
North and South American	49	Northern Coniferous Forest	8
Circumboreal	10		
Pantropical	4		
Subtotals	118		171

TABLE III. Number of woody species in selected flood plain forests.

Region	River	Trees	Shrubs	Vines	Total	Source
Eastern Nebraska	Lower Platte at Fremont	22	19	7	48	Current Study
Eastern Nebraska	Lower Platte at Louisville	10	5	3	18	Morrison, 1935
Eastern Nebraska	Weeping Water River	21	18	6	46	Weaver *et al.*, 1925
Eastern Nebraska–Eastern Iowa	Missouri River	20	15	5	40	Weaver, 1960; Aikman, 1929
Eastern North Dakota–Western Minnesota	Red River	12	21	4	37	Wanek, 1967
Central North Dakota	Missouri River	10	22	6	38	Keammerer *et al.*, 1975
Western Kansas	Arkansas River	14	3	4	22	Hulett *et al.*, 1968
North-Central Oklahoma	Canadian River	42	12	12	66	Rice, 1965
Southwestern Indiana	White River	49	14	8	71	Lee, 1945
Western Indiana	Wabash and Tippecanoe Rivers	54	21	10	85	Lindsey *et al.*, 1961

Valley Channel (Lueninghoener, 1947). Since then the river has flowed along a circuitous, east-southeasterly course from near Morse Bluff to Ashland, greatly widening and deepening the valley. At the study site the following prominent physiographic features were formed: (1) steep river bluffs, nearly 40 m high, which fringe the south or main channel; (2) a highly braided channel, which widened to over 1.3 km by 1865; and (3) a large river island, built up by successive episodes of flooding and vegetative stabilization. Later geologic and climatic events, persisting through Late Pleistocene (Wisconsinian) to post-glacial or recent time, also significantly influenced the vegetation. When the terminus of the Wisconsin glaciers fluctuated some 160 to 200 km to the north of the study site, from about 22,000 to 12,000 B.P. (Ruhe, 1969), the climate was considerably colder. The area was also subject to high winds and blowing dust at that time, as evidenced by thick deposits of loess (Lugn, 1968). Paleoecological studies in northeast Kansas (Grüger, 1973), north-central Nebraska (Watts and Wright, 1966), and western Iowa (Ruhe, 1969) have indicated that a coniferous forest, or at least a coniferous forest-grassland parkland, covered much of the prairie and plains south of the ice sheet, which likely included the study area. The flora was apparently similar to present-day boreal forests of Manitoba and Saskatchewan, some 1100 km to the north. In northeastern Kansas, about 180 km south of the study site, pollen-stratigraphic and macrofossil studies indicated that willow, spruce, birch, alder, and various boreal-marsh species grew along the Delaware River during full- and late-glacial time, from 23,000 to 12,000 B.P. (Grüger, 1973). After 11,500 B.P. or in early post-glacial time, coincident with climatic warming and widespread retreat of the ice sheet, deciduous forest spread over the area. It included tree species of genera such as *Quercus, Platanus, Ulmus, Fraxinus,* and *Carya.* Between 10,000 and 5,000 B.P. a drier and warmer climatic period developed, and prairie spread over the area. The onset of somewhat cooler and moister conditions after 5,000 B.P. led to the development of prairie-border vegetation (woodland along the valleys and prairie on the upland), which presists to the present in northeastern Kansas.

Although paleoecological data are lacking for the study area, the pattern of floristic change may be similar to that for the Kansas site except for some differences due to more extreme periglacial-climatic conditions during glacial periods. Present-day boreal species may be descendants of the late-glacial vegetation rather than of recent colonizers from northerly locations. In early post-glacial time deciduous forest may also have been more widespread in the study area region than at present. Disjunct stands of deciduous forest, containing bitternut hickory (*Carya cordiformis*) and red oak (*Quercus rubra*), have been observed along lower reaches of the Platte and Elkhorn rivers, respectively (personal observation). A reach of the Platte Valley from Morse Bluff to Fremont, in particular, provides favorable habitats and conditions for the persistence of both upland and flood plain deciduous forests. These include: (1) the presence of steep bluffs and deep ravines along the south valley border which afford protection from adverse climatic stresses; (2) the cooling and drought-modifying effect of abundant surface- and ground-water supplies of the flood plain; and (3) the diverse physiography of the flood plain, including numerous riverine-islands, which supply a wide range of microhabitats and afford protection from prairie fires.

In early post-glacial times as boreal-marsh, pond, and riparian species waned, many temperate aquatic species would have been able to colonize the area, likely assisted in dispersal by migratory birds. Several warmth-loving aquatic species, *e.g.* those confined to central and southern portions of the United States, however, would not have arrived until further climatic warming occurred. At this time, modern prairie vegetation also likely arrived, including a warm-season species element of the tall-grass prairie (*Andropogon gerardii, Panicum virgatum,* and *Silphium* sp.) and a xeric sandhill-prairie element (*Sporobolus cryptandrus, Eragrostis spectabilis, Froelichia gracilis, Croton texensis, Paspalum ciliatifolium,* and *Plantago patagonica*). The latter element apparently migrated from westerly locations, most likely down the Platte Valley.

In post-settlement time, the accidental or deliberate introduction of competing exotic weeds or cultigens has added a new floristic element to the vegetation. In the past century 32 naturalized or adventive species have colonized the study area. These include weeds of cultivated fields and roadsides, many of which became established and spread after man-made disturbances or floods occurred. Only a few cultigens are known to occur in the study area; however, a plan to introduce ornamental and fruit trees to Fremont Island in the early 1900s was described by J. J. Hawthorne (letter to editor of the *Fremont Tribune*, Louis E. May Historical Museum, Fremont). There is little field evidence, however, that the plan was successfully implemented in Hormel Park.

Future Management Needs and Uncertainties

Assuming insignificant departures from current climatic patterns do not occur, and adverse, site-specific environmental disturbances by man can be avoided, other factors still could alter or eliminate certain vegetation types, thus reducing the species richness of the study area. Possible changes in river regimen constitute the most potential threat, since all habitats at the study site are directly or indirectly affected by river flows. High flows supplement the water supplies available to forest vegetation on higher topographic sites, while aquatic vegatation actually depends upon those flows to supply water to depressions, old chutes, and the old north channel. Low flows in summer permit colonization and reproduction by riparian and ruderal species within higher channel areas and along the banks. Extremely high flows (floods) provide new diaspores to the area, flush or deepen old scour-channels or main-channels, change bank configurations, and create new surfaces for plant colonization. The March 1978 flood, while destroying significant areas of high banks, created extensive areas of lower bars which were colonized by early successional species. Three additional species were collected in this area after the flood. The flood also inundated extensive pond, marsh, and old channel areas for up to three months. The added water supply restored vigor to pond and marsh vegetation and eliminated seedlings of cottonwoods from the north channel which had become established during previous low-flow and drought years.

Periodic flows in the Platte River are needed to exceed the current channel carrying capacity. These are estimated to be 707.5-849 m^3/s (25,000-30,000 cfs) for the reach from North Bend to Fremont (Anonymous, 1975b). Without these flows many aquatic species will be replaced by terrestrial forms already abundant in the area, and willow-cottonwood forests will develop in old scour-channels and in the old north channel. In addition, the vigor of the subclimax forest on higher topographic sites might decline as ground-water tables drop.

Future management of the area should address the desirability of maintaining the existing plant-community diversity and species richness. Provision for periodic high-water flows are needed, despite the fact that they induce some bank erosion. Future work is needed to quantify these flows and to develop ecologically sound methods of reducing bank erosion and loss of park lands. Greater protection from unnecessary human intrusion or vandalism, and from adverse impacts induced by upstream or downstream flood plain modification, are also needed.

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ANNOTATED LIST

EQUISTEOPHYTA

Equistaceae

Equisetum laevigatum A. Br. (M-G-3-AU)
Equisetum arvense L. (F-G-4-AU)

PINOPHYTA

Cupressaceae

**Juniperus virginiana* L. (F-PH-5-ES)

MAGNOLIOPHYTA

LILIATAE

Alismataceae

Alisma subcordatum Raf. (P-H-3-HY)
Sagittaria latifolia Willd. (P-H-3-HY)

Juncaceae

Elaeocharis acicularis (L.) R. and S. (P-G-2-HY)
Elaeocharis macrostachya Britt. (P-H-3-HY)
**Elaeocharis obtusa* (Willd.) Schult. var. *ovata* (Roth) Drapalik and Mohlenbrock (M-T-1-HY)
**Juncus tenuis* Willd. (RD-H-5-PO)

Cyperaceae

Carex amphibola Steud. var. *turgida* Fern. (F-H-4-ES)
Carex blanda Dewey (F-H-3-ES)
Carex brevior (Dewey) Mack. (M-H-3-HY)
**Carex cephalophora* Muhl. (F-H-4-ES)
**Carex cristatella* Britt. (F-H-4-ES)
**Carex davisii* Schwein. and Torr. (M-G-3-HY)
Carex lacustris Willd. (M-G-3-HY)
Carex laeviconica Dewey (M-G-3-HY)
Carex lanuginosa Michx. (M-G-2-HY)
Carex lupulina Muhl. (M-H-3-HY)
**Carex rosea* Schkuhr. (F-H-4-ES)
Carex scoparia Schkuhr. (F-H-3-ES)
Carex tribuloides Wahl. (F-H-5-ES)
Carex vulpinoidea Michx. (M-G-3-HY)
Cyperus acuminatus Torr. and Hook. (RP-T-3-HY)
Cyperus aristatus Rottb. (RP-T-3-HY)
Cyperus esculentus L. (RP-G-3-HY)
Cyperus ferruginescens Boeckl. (RP-T-3-HY)
Cyperus schweinitzii Torr. (RP-G-3-HY)
Scirpus americanus Pers. (P-G-2-HY)
**Scirpus atrovirens* Willd. var. *atrovirens* (M-G-2-HY)

MAGNOLIATAE

Salicaceae

Populus deltoides Marsh (F-PH-5-AN)
Salix amygdaloides Anderss. (F-PH-3-AN)
Salix exigua Nutt. ssp. *interior* (Rowlee) Cronq. (RP-PH-2-AN)
Salix nigra L. (M-PH-2-AN)
Salix rigida Muhl. var. *watsonii* (Bebb.) Cronq. (M-PH-1-AN)

Juglandaceae

**Juglans nigra* L. (F-PH-2-ES)

Fagaceae

Quercus macrocarpa Michx. (F-PH-4-ES)

Betulaceae

**Ostrya virginiana* (Mill.) K. Koch (F-PH-1-ES)

Ulmaceae

Celtis occidentalis L. (F-PH-4-ES)
Ulmus americana L. (F-PH-5-AN)
Ulmus rubra Muhl. (F-PH-3-AN)

Moraceae

Cannabis sativa L. (RD-T-2-ES-N)
Morus alba L. (F-PH-5-ES-N)

Urticaceae

Boehmeria cylindrica (L.) Sw. (F-G-2-PO)
Laportea canadensis (L.) Wedd. (F-G-4-PO)
**Parietaria pensylvanica* Muhl. (F-T-4-PO)
Urtica dioicia L. ssp. *gracilis* (Ait.) Selander (F-H-2-EP

Polygonaceae

Polygonum aviculare L. (RD-T-3-PO)
Polygonum coccineum Muhl. (M-H-2-HY)
**Polygonum hydropiperoides* Michx. (M-H-2-HY)
Polygonum lapathifolium L. (RP-T-2-HY)
Polygonum persicaria L. (M-T-3-HY-N)
Polygonum punctatum Ell. (M-H-4-HY)
**Polygonum scandens* L. (F-H-2-AN)
Rumex crispus L. (MW-H-4-PO-N)
Rumex maritimus L. var. *fueginus* (Phil.) Dusen (RP-T-2-PO)
**Rumex obtusifolius* L. (RP-H-2-PO-N)

Chenopodiaceae

Chenopodium album L. (RD-T-4-ES-N)
**Cycloloma atriplicifolium* (Spreng.) Coult. (RD-T-2-A
**Kochia scoparia* (L.) Schrad. (RD-T-2-AN-N)

Amaranthaceae

**Amaranthus rudis* Sauer (RP-T-3-HY)
Froelichia gracilis (Hook) Moq. (PR-T-2-AN)

Poaceae

**Agropyron repens* (L.) Beauv. (RD-G-2-PO-N)
Agrostis hyemalis (Walt.) B.S.P. (M-H-2-AN)
Agrostis stolonifera L. (MW-H-5-PO-N)
Andropogon gerardii Vitman (PR-H-2-AN)
Bromus inermis ssp. *inermis* Leyss (RD-H-2-AN)
Bromus tectorum L. (RD-T-4-An-N)
Cenchrus longispinus (Hack.) Fern. (RD-T-2-EP)
**Cinna arundinacea* L. (F-H-3-ES)
Dactylus glomerulata L. (MW-H-3-AN-N)

Digitaria sanguinalis (L.) Scop. (RD-T-3-PO-N)
**Echinochloa crusgallii* (L.) Beauv. (RD-T-3-PO-N)
Eleusine indica (L.) Gaertn. (RD-T-2-PO-N)
Elymus canadensis L. (PR-H-3-AN)
Elymus villosus Muhl. (F-H-2-AN)
Elymus virginicus L. var. *submuticus* (F-H-4-AN)
Eragrostis hypnoides (Lam.) B.S.P. (RP-T-4-HY)
Eragrostis pectinacea (Michx.) Nees. (RP-T-4-HY)
Eragrostis spectabilis (Pursh) Steud. (PR-H-2-AN)
Festuca obtusa Biehler (F-H-4-ES)
**Glyceria grandis* S. Wats. (M-H-2-HY)
Glyceria striata (Lam.) Hitchc. (M-H-3-HY)
Hordeum jubatum L. (RD-H-3-AN)
Hordeum pulsillum Nutt. (RD-T-3-AN)
Leersia oryzoides (L.) Sw. (M-H-2-HY)
**Leersia virginica* Willd. (F-H-2-ES)
Muhlenbergia frondosa (Poir.) Fern. (F-H-2-ES)
Muhlenbergia racemosa (Michx.) B.S.P. (F-H-3-ES)
Panicum capillare L. (RD-T-3-AN)
Panicum dichotomiflorum Michx. (MW-T-2-PO)
Panicum lanuginosum Ell. (F-H-4-ES)
Panicum oligosanthes var. *scriberianum* (Nash) Fern. (PR-4-3-ES)
Panicum virgatum L. (PR-G-3-ES)
Paspalum ciliatifolium Michx. (PR-H-3-ES)
Phalaris arundinacea L. (M-G-3-HY)
Phleum pratense L. (MW-H-3-PO-N)
Poa compressa L. (F-H-2-PO-N)
Poa pratensis L. (MW-G-5-PO)
Setaria viridis (L.) Beauv. (RD-T-3-PO-N)
**Spartina pectinata* Link. (M-H-2-PO)
Sphenopholis obtusata (Michx.) Scribn. var. *major* (Torr.) Erdman (F-H-3-PO)
Sporobolus cryptandrus (Torr.) Grag. (PR-H-3-PO)
Tridens flavus (L.) Hitchc. (F-H-3-PO)

Typhaceae

Typha angustifolia L. (P-H-3-AN)
Typha latifolia L. (P-H-3-AN)

Orchidaceae

**Spiranthes cernua* (L.) Rich. (PR-H-1-AN)
**Arisaema triphyllum* (L.) Schott. (F-G-3-ES)

Lemnaceae

Lemna minor L. (P-H-4-HY)
Spirodela polyrhiza (L.) Schleid. (P-H-4-HY)

Commelinaceae

**Commelina communis* L. (RD-T-3-PO-N)

Lilaceae

Allium canadense L. var. *canadense* (F-G-3-PO)
**Asparagus officinalis* L. (MW-G-3-ES-N)
**Hemerocallis fulva* L. (MW-G-2-PO-N)
Polygonatum biflorum (Walt.) Ell. (F-G-3-ES)
Smilacina stellata (L.) Desf. (F-G-4-ES)
Smilax hispida Muhl. (F-PH-5-ES)

Nyctaginaceae

**Mirabilis nyctaginea* (Michx.) MacM. (MW-G-2-PO)

Portulacaceae

**Portulaca oleracea* L. (RD-T-2-PO-N)

Caryophyllaceae

Cerastium brachypodium (Engelm.) Robins (RD-T-3-PO)
**Silene stellata* (L.) Ait.f. (F-H-2-PO)

Ceratophyllaceae

Ceratophyllum demersum L. (P-H-1-HY)

Ranunculaceae

Anenome canadensis L. (MW-H-4-ES)
Anenome virginiana L. (F-H-2-AN)
**Clematis virginiana* L. (F-PH-1-AN)
Ranunculus abortivus L. (M-H-4-ES)
Ranunculus scleratus L. (M-T-4-HY)
Thalictrium dasycarpum Fisch and Ave'Lall (F-H-2-EP)

Berberidaceae

**Berberis thunbergii* (Dcne.) Vernd. (F-PH-1-ES-N)

Menispermaceae

Menispermum canadense L. (F-CH-2-ES)

Brassicaceae

Capsella bursa-pastoris (L.) Medic. (RD-T-4-PO-N)
**Descurainea sophia* (L.) Webb (RD-T-2-PO)
Draba reptans (Lam.) Fern. (RD-T-3-PO)
**Lepidium densiflorum* Schrad. (RD-T-4-PO)
**Rorippa obtusa* (Nutt.) Britt. (M-T-3-HY)
Rorippa palustris (L.) Bess. var. *fernaldiana* (Butt and Abbe) Stuckey (M-T-3-HY)

Crassulaceae

Penthorum sedoides L. (RP-H-2-HY)

Saxifragaceae

**Ribes missouriense* Nutt. (F-PH-5-ES)

Rosaceae

**Agrimony gryposepala* Wallr. (F-H-3-EP)
Fragaria virginiana Duchn. var. *illinoiensis* (Prince) Gray (MW-H-4-ES)
Geum canadense Jacq. (F-H-4-EP)
**Potentilla norvegica* L. (F-T-2-PO)
**Prunus americana* Marsh (F-PH-2-ES)
Prunus virginiana L. (F-PH-2-ES)
Pyrus malus L. (MW-PH-1-ES-N)
**Rosa multiflora* Thumb. (F-PH-2-ES-N)
Rubus occidentalis L. (F-PH-2-ES)

Fabaceae

Amorpha fruiticosa L. (RP-PH-3-PO)
Amphicarpa bracteata (L.) Fern. (F-H-2-ES)
Cassia fasciculata Michx. (RP-T-4-AU)
Desmanthus illinoensis (Michx.) MacM. (M-H-2-PO)
Desmodium canescens (L.) DC. (F-H-3-EP)
**Desmodium glutinosum* (Muhl.) Wood. (F-H-3-EP)
Desmodium paniculatum (L.) DC. (F-H-3-EP)
Gleditsia triancanthos L. (F-PH-2-ES)
Glycyrrhiza lepidota Pursh (PR-H-2-EP)
Medicago lupulina L. (RD-T-4-PO-N)
Melilotus alba (L.) Desr. (RD-H-3-ES-N)
Melilotus officinalis (L.) Lam. (RD-H-3-ES-N)
Strophostyles helvola (L.) Ell. (RP-T-2-AU)
**Trifolium pratense* L. (MW-H-3-PO-N)
Trifolium repens L. (MW-CH-5-PO-N)

Oxalidaceae

Oxalis stricta L. (RD-H-4-AU)

Rutaceae

Zanthoxylum americanum Mill. (F-PH-4-ES)

Euphorbiaceae

Croton texensis (Klotzsch) Muell-Arg. (PR-T-2-AU)
Euphorbia glyptosperma Engellm. (RD-T-3-AU)
Euphorbia hexagona Nutt. (PR-T-2-AU)
Euphorbia maculata L. (RD-T-3-AU)
Euphorbia marginata Pursh (PR-T-2-AU)
Euphorbia nutans Laq. (RD-T-2-AU)

Anacardiaceae

Rhus glabra L. (F-PH-3-ES)
Toxicodendron radicans (L.) Kuntze (F-PH-5-ES)

Celastracae

Celastrus scandens L. (F-PH-2-ES)
Euonymus atropurpureus Jacq. (F-PH-1-ES)

Aceraceae

Acer negundo L. (F-PH-3-AN)
Acer saccharinum L. (F-PH-3-AN)

Balsaminaceae

**Impatiens biflora* Walt. (F-T-2-AU)

Rhamnaceae

**Rhamnus catharticus* L. (F-PH-4-ES-N)

Vitaceae

Parthenocissus quinquefolia (L.) Planck. (F-PH-4-ES)
Vitis riparia Michx. (F-PH-2-ES)

Tilaceae

Tilia americana L. (F-PH-4-AN)

Malvaceae

Abutilon theophrasti Medic. (RD-T-2-PO-N)
Callirhoe involucrata (T. and G.) Gray (RD-H-2-PO)

Violaceae

Viola missouriensis Greene (F-H-4-AU)

Elaeagnaceae

**Elaeagnus angustifolia* L. (MW-PH-1-ES-N)

Lythraceae

Ammannia coccinea Rottb. (RP-T-2-HY)
Lythrum dacotanum Nieuw. (M-H-2-HY)

Onagraceae

**Circaea lutetiana* L. ssp. *canadensis* (L.) Asch. and Magnus (F-G-3-EP)
**Oenothera biennis* L. ssp. *centralis* Munz. (RP-H-4-PO)

Apiaceae

Cicuta maculata L. (M-H-1-HY)

Cryptotaenia canadensis (L.) Dcne. (F-H-4-PO)
Osmorhiza claytonii (Michx.) Clarke (F-H-2-EP)
**Osmorhiza longistylis* (Torr.) Dcne. (F-H-2-EP)
Sanicula canadensis L. (F-H-2-EP)
**Sanicula gregaria* Bickn. (F-H-5-EP)
Zizia aurea (L.) Koch. (MW-H-2-PO)

Cornaceae

Cornus amomum ssp. *oblique* (Raf.) J.S. Wils. (F-PH-1-ES)
**Cornus drummondii* Mey. (F-PH-5-ES)
**Cornus foemina* (Mill.) ssp. *racemosa* (Lam.) J.S. Wils. (F-PH-2-ES)
Cornus stolonifera Michx. (F-PH-2-ES)

Primulaceae

Androsace occidentalis Pursh (RD-T-2-PO)
Lysimachia ciliata L. (M-H-2-PO)
†*Lysimachia nummularia* L. (M-CH-1-PO)

Oleaceae

Fraxinus americana L. (F-PH-2-AN)
Fraxinus pennsylvanica Marsh var. *subinterrima* (Vahl.) Fern. (F-PH-3-AN)

Apocynaceae

Apocynum cannabinum L. (M-H-3-AN)

Asclepiadaceae

Asclepias incarnata L. (M-H-2-AN)
Asclepias verticillata L. (PR-H-3-AN)
**Asclepias syriaca* L. (RD-G-4-AN)

Convolvulaceae

Convolvulus sepium L. (RD-G-3-PO)

Hydrophyllaceae

Ellisia nyctelea L. (RD-T-4-AU)

Boraginaceae

**Hackelia virginiana* (L.) I.M. Johnst. (F-H-4-EP)

Verbenaceae

Phyla lanceolata (Michx.) Greene (M-H-4-HY)
Verbena hastata L. (M-H-2-HY)
Verbena stricta Vent. (PR-H-2-PO)
Verbena urticifolia L. (F-H-3-PO)

Lamiaceae

**Agastache nepetoides* (L.) O. Ktze. (F-H-2-PO)
Heodeoma hispida Pursh. (RD-T-3-PO)
Leonurus cardiaca L. (F-H-4-PO-N)
**Nepeta cataria* L. (F-H-2-PO-N)
**Physostegia virginiana* (L.) Benth. (M-H-1-HY)
**Prunella vulgaris* L. (MW-H-4-PO)
Lycopus americanus Muhl. (M-H-2-HY)
Lycopus virginicus L. (M-H-2-HY)
Mentha arvensis L. (M-H-3-PO)
Scutellaria lateriflora L. (M-H-2-HY)
**Stachys tenuifolia* Willd. (F-H-2-PO)
**Teucrium canadense* L. var. *virginanum* (L.) Eaton (M-H-2-PO)

Solanaceae

Physalis virginiana Mill. (RD-G-3-ES)
Solanum americanum Mill. (RD-T-3-ES)

Scrophulariaceae

Gerardia tenuifolia Vahl. (RP-T-2-HY)
**Leucospora multifida* (Michx.) Nutt. (RP-T-1-HY)
**Limosella aquatica* L. (RP-T-1-HY)
**Lindernia dubia* (L.) Penn. (RP-T-1-HY)
Mimulus ringens L. (M-H-2-HY)
**Verbascum thapsus* L. (RD-H-3-PO)
**Veronica peregrina* L. var. *xalapensis* (H.B.K.) St. John and Warren (M-T-4-HY)

Bignoniaceae

**Campsis radicans* (L.) Seem. (F-PH-1-AN)
**Catalpa speciosa* Warder (F-PH-2-AN)

Phyrmaceae

Phyrma leptostachya L. (F-H-3-EP)

Plantaginaceae

Plantago patagonica Jacq. var. *patagonica* (RD-T-3-PO)
Plantago rugelii Dcne. (RD-H-4-PO)
**Plantago virginica* L. (RD-H-2-PO)

Gentianaceae

Gentiana andrewsii Griseb. (M-H-1-AN)

Rubiaceae

Galium aparine L. (F-T-5-EP)
Galium trifidum L. (M-H-4-HY)

Caprifoliaceae

**Lonicera tatarica* L. (F-PH-2-ES-N)
Sambucus canadensis L. (F-PH-2-ES)
Symphoricarpos orbiculatus Moench (F-PH-5-ES)
**Viburnum lentago* L. (F-PH-1-ES)

Cucurbitaceae

**Sicyos angulatus* L. (F-T-1-EP)

Campanulaceae

Campanula americana L. (F-T-2-PO)
Triodanis perfoliata (L.) Nieuw. (RD-T-3-PO)

Asteraceae

Achillea millefolium L. ssp. *lanulosa* (Nutt.) Piper (PR-H-1-AN)
Arbrosia artemisiifolia L. (RD-T-2-ES)
**Ambrosia trifida* L. (RD-T-2-ES-N)
Artemisia ludoviciana Nutt. var *ludoviciana* (PR-G-2-PO)
Aster ericoides L. (PR-H-4-AN)
Aster novae-angliae L. (F-H-1-AN)
**Aster ontarionus* Wieg. (M-H-3-AN)
Aster praealtus Poir. (M-H-3-AN)
Bidens cernua L. (M-T-4-PO)
Bidens comosa (Gray) Wiegand-Fassett (M-T-3-PO)
Bidens frondosa L. (M-T-2-PO)
Cirsium altissimum (L.) Spreng. (F-H-2-AN)
Cirsium vulgare (Savi) Ten. (RD-H-2-AN-N)
**Chyrsanthemum leucanthemum* L. (RD-H-1-AN-N)
Conyza canadensis (L.) Cronq. (RD-T-4-AN)
Eclipta alba (L.) Hassk. (RP-T-3-HY)
Erigeron philadelphicus L. (F-T-3-AN)
Erigeron strigosus Muhl. (PR-T-3-AN)
Eupatorium altissimum L. (F-H-2-AN)
Eupatorium rugosum Houtt. (F-H-4-AN)
**Helenium autumale* L. (M-H-1-AN)
Helianthus annuus L. (RD-T-3-ES)
Helianthus petiolaris Nutt. (PR-T-3-ES)
Helianthus tuberosus L. (PR-G-3-ES)
**Lactuca floridana* (L.) Gaertn. (F-H-3-AN)
**Matricaria matricarioides* (Less.) Porter (RD-T-2-PO)
Rudbeckia laciniata L. (F-H-3-AN)
Silphium integrifolium Michx. (PR-H-2-AN)
**Silphium perfoliatum* L. (PR-H-2-AN)
Solidago canadensis (L.) var. *gilvocanescens* Rydb. (F-H-3-AN)
Solidago gigantea Ait. var. *serotina* (Kuntze) Cronq. (PR-H-3-AN)
Solidago graminifolia (L.) Salisb. var. *gymnospermoides* (Greene) Croat (PR-H-2-AN)
Taraxacum officinale Weber (RD-H-4-AN-N)
Tragopogon dubius Scop. (RD-H-3-AN-N)
**Vernonia gigantea* (Walt.) Trel. ssp. *gigantea* (M-H-2-AN)
Xanthium strumarium L. (RP-T-4-PO)

KEY TO SYMBOLS

Habitat

F = forest; M = marsh; RP = riparian; PR = prairie; MW = meadow; P = pond; RD = ruderal

Abundance

1 = very rare; 2 = rare; 3 = infrequent; 4 = abundant; 5 = very abundant

Life Form

H = hemicryptophyte; T = therophyte; PH = phanerophyte G = geophyte; CH = chamaephyte

Dispersal Type

ES = endozoochore and synzoochore; AU = autochore; AN = anemochore; EP = epizoochore; HY = hydrochore; PO = polychore

N = naturalized

*New records for Dodge County.

†New record for Nebraska.