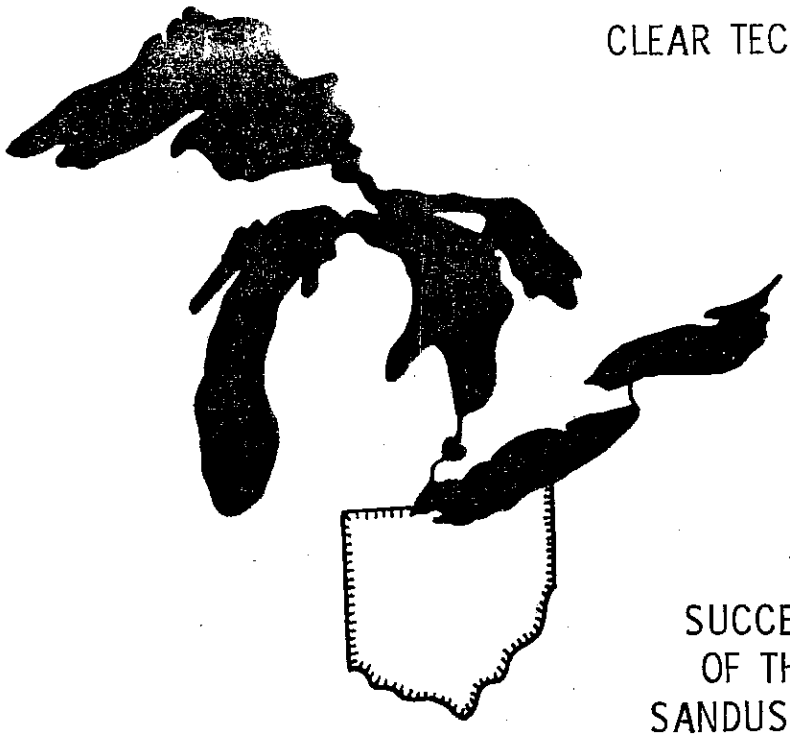

CLEAR TECHNICAL REPORT NO. 100

VASCULAR FLORA AND THE SUCCESSION OF PLANT COMMUNITIES OF THE EARTHEN DIKES BORDERING SANDUSKY BAY AND WESTERN LAKE ERIE

by

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PREFACE

The following research was prepared by Robert J. Bartolotta as partial fulfillment for a M.S. degree in the Department of Botany. Research was conducted at the time of extensive earthen dike rebuilding following the destruction of the former dikes by the severe northeast storm of November 1972 and subsequent years of high water.

Dr. Ronald L. Stuckey, Department of Botany, served as advisor; other members of the reading and examination committee were Drs. Emanuel D. Rudolph and Carroll A. Swanson, Department of Botany. Financial support for printing this document was provided by the U.S. Fish and Wildlife Service (Project No. RF 710779). On behalf of the Center for Lake Erie Area Research, I am pleased that we are able to reproduce this research effort and make it available to other scientists.

Charles E. Herdendorf
Director
October 10, 1978

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INTRODUCTION

Objectives

The earthen dikes bordering western Lake Erie and Sandusky Bay appear as long, narrow islands through marshes, lakes, and bays and as borders along roads, ditches, and lakeshores. The dikes are man-made structures built for the protection of the landmasses and the management of the bodies of water. Gordon (1969, pp. 26-27), among others, has noted that dikes and pumps have been utilized to reclaim the marshes for agricultural purposes, to "protect the marsh vegetation from destruction by the wind-activated waters of Lake Erie," and to preserve the marshes for waterfowl hunting and muskrat production.

Regarding the floras of these dikes, Langlois (1954, pp. 102, 104) made the following observation: "...succession of plants...on the levees [dikes] has distinctive characteristics." He did not go into details, other than to mention that "...nodding smartweed appears promptly on newly dredged levees anywhere in the wetland region." Since then, our knowledge of the flora of the dikes in the marshes of northwestern Ohio has improved, but has been limited mostly to lists of vascular plants, as in Andrews (1952), Lowden (1967, 1969), and Meeks (1963). In their studies, few analyses were included of the plant communities and the successional stages of these communities.

During the summer of 1976, a floristic reconnaissance of selected dikes was begun. The major objectives were to develop lists of plants for each dike, determine the number of consecutive growing seasons of the plants on each dike, and equate the lists of plants with the number

of consecutive growing seasons to determine the species composition of the flora and the succession of the plant communities. Secondarily considered were the effects of the adjoining plant communities and deposits in the marsh sediments as sources of seeds for the resultant flora of each dike.

Study Areas

Three marshes (all subjected to waterfowl management practices) with well documented histories of construction of dikes were chosen as sites for the field work. South of Port Clinton on Route 53 in Bay Township of Ottawa County and Rice and Riley Townships of Sandusky County is the location of the marsh owned by the Winous Point Shooting Club (designated WI on Figure 1). This marsh has exposure to Muddy Creek Bay, the Sandusky River, and Sandusky Bay. Apart from other marshes in the vicinity of the Winous Point Shooting Club, most of the adjoining land is agricultural. This marsh is managed by Dr. Robert L. Meeks and Mr. Robert Hoffman. Nine dikes on the Bay Township property only were studied during the summers of 1976 and 1977. A general knowledge of the flora was obtained during the first season of field work. During the second season of field work, permanent transects were established on certain dikes to obtain frequencies and relative densities of the species in order to quantify the species composition of the flora.

An extensive area of marshland with exposure to Lake Erie and the eastern shore of Sandusky Bay occurs in Margaretta Township in Erie County east of the town of Bayview at the intersection of Routes 2 and

269. Much of the marshland is owned by the Edward Moxley family of Port Clinton for use as a private hunting area. Seven dikes at Moxley's Marsh (designated MO on Figure 1) were studied in 1976 and 1977 using the same guidelines established for the dikes at the Winous Point Shooting Club.

North of Route 2 in Jerusalem Township of Lucas County and in Benton and Carroll Townships of Ottawa County lies the Magee Marsh Wildlife Area of the Ohio Department of Natural Resources (designated MA on Figure 1). This marsh is not exposed to Sandusky Bay, but does have approximately two miles of exposed shoreline to Lake Erie. This 2100-acre state hunting land is managed by Mr. Karl Bednarik. Five dikes were studied during 1976 and 1977. Permanent transects were not established at Magee Marsh. Lists of the plants were prepared and all abundances were estimated.

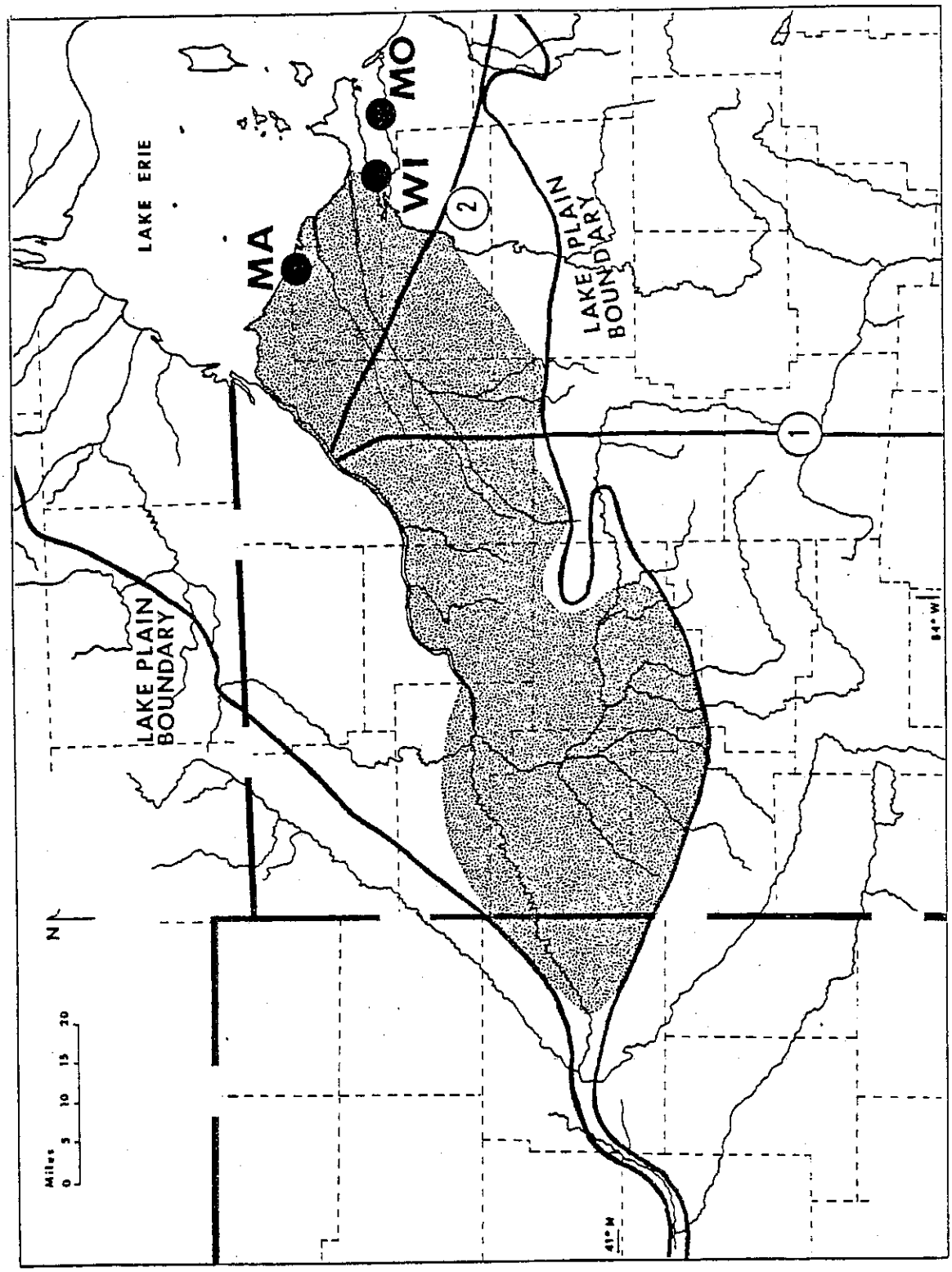
Glacial Geology

Beginning approximately 15,000 yrs. BP (= years before present) during deglaciation which occurred in the Late Wisconsin Stage of the Pleistocene Epoch of the Quaternary Period, a series of postglacial lakes were formed whose successors are the Great Lakes. Much of northwestern Ohio including Erie, Lucas, and Ottawa Counties was previously under the waters of postglacial Lakes Maumee, Arkona, Ypsilanti, Whittlesey, Warren, Wayne, Grassmere, and Lundy. These lakes existed from approximately 15,000 yrs. BP to 12,500 yrs. BP. They were impoundments between the land of higher elevation to the south and the glacier to the north; the area of land covered fluctuated with readvancements and retreats of the glacier. The sandy beach ridges of

FIGURE 1.--Physiographic Features of Northwestern Ohio and the Locations of the Marshes.

LEGEND

———	Lake Plain Boundary. The Lake Plain is all of the land toward Lake Erie within this boundary.
	Area of the Black Swamp prior to 1900.
1	Hull's Trace.
2	Maumee-Western Reserve Road.
MA	Magee Marsh (Ottawa and Lucas Counties).
MO	Moxley's Marsh (Erie County).
WI	Winous Point Shooting Club (Ottawa and Sandusky Counties).


LAKE ERIE
MA
WI
MO
LAKE PLAIN BOUNDARY
LAKE PLAIN BOUNDARY
2
84° W
41° N
N
Miles
0 5 10 15 20

many of the lakes are still present, as evidenced by many of the east-west state and U.S. highways and railroads through northern Ohio which were built on these elevated ridges. By 12,500 yrs. BP, Early Lake Erie was established. Drainage was through the Niagara River to Lake Iroquois, the predecessor of Lake Ontario. In the intervening 12,500 years, the water level of Lake Erie has risen continually more or less because of isostatic rebound of the crust (Flint, 1971, pp. 561-570; Forsyth, 1959).

Physiographically, the result of this most recent glaciation and especially the postglacial lakes has been the formation of the lake plain of Ohio (see Figure 1, partially redrawn from Leverett (1902, pl. 2)). The bedrock was scoured and essentially smoothed, yielding very flat topography with relief less than 100 feet above lake level. In northwestern Ohio, the lake plain is dissected by shallow streams and rivers of which the Maumee River is the most significant.

Beneath the marshes surveyed, the bedrock varies. At Magee Marsh and Winous Point Shooting Club, the bedrock is dolomite of the Bass Island Group (= the Monroe Group) which originated late in the Silurian Period. Most of the bedrock of Ottawa County is of the Bass Island Group. High quality gypsum and dolomite have been quarried throughout the county since the 1830's (Stout, 1941, pp. 412, 418-423). Atop the bedrock, there is from 0-25 feet of glacial till mostly composed of clay and lacustrine clays. At Moxley's Marsh in Erie County, the bedrock is dolomite limestone of the Columbus Formation (= Corniferous Limestone) which originated in the Devonian Period. This bedrock is covered by glacial drift and lacustrine clays (Stout,

1941, pp. 358-367).

Soils

The soils at Magee Marsh, Moxley's Marsh, and Winous Point Shooting Club are derived from the lacustrine deposits and the glacial till. Although the soils are variable, they belong to the Toledo silty clay series. Characteristically, the soils are calcareous and clayey. The drainage is poor and must be facilitated by ditching and diking. The soils are very productive when drained. The amount of available moisture is high, as are the concentrations of nutrients and organic matter. The pH is slightly alkaline (Paschall, et al, 1928; Redmond, et al, 1971).

Land Usage in Northwestern Ohio and Early History of the Marshes

Prior to the signing of the Treaty of Greenville in 1795 (Darke County, Ohio), all of northwestern Ohio was Indian territory with only a scattering of European white settlers. Most of this area consisted of extensive swamps and marshes, best known as the Black Swamp (shaded area on Figure 1). Shortly after 1800, a few white settlements appeared along the Maumee and Sandusky Rivers. The Treaty of Brownstown in 1808 (south of Detroit, Michigan) included a provision to cede a tract of land from the Maumee Rapids (now in Perrysburg, Wood County, Ohio) to the western border of the Connecticut Western Reserve (in southeastern Sandusky County, Ohio). This was to be the first road across the Black Swamp providing an overland route between Maumee and Cleveland (Cuyahoga County, Ohio). The road was not completed until 1827. The

War of 1812 which was fought for the control of Lake Erie and the recapture of Detroit, required that troops be deployed in northwestern Ohio. For these troops, the first north-south route (designated 1 on Figure 1) through the Black Swamp known as Hull's Trace (today this corresponds to U.S. highway 68) was constructed as a supply line from Urbana, Ohio to Detroit, Michigan. In 1822, a bill was passed in Congress to build a road across the Black Swamp to make it suitable for agriculture by artificial drainage. In 1827, the Maumee-Western Reserve Road (designated 2 on Figure 1) was completed (today it can be equated with U.S. highway 20 between Perrysburg, Wood County and Bellevue, Huron County, Ohio). The road was miserable, hence few settlers used this route. Lake Erie was utilized as an east-west route, as were the canals which were constructed between 1830 and 1850 (Kaatz, 1955).

Northwestern Ohio was the last part of the state to be ceded from the Indians, after no less than seventeen treaties between 1795 and 1842. The first boundaries for this part of the state and most township subdivisions were established by 1821. The Wyandot Indians ceded the last of the Indian lands in this part of the state in 1842 (Sherman, 1925, pp. 131-146). Concomitantly, the population of whites did not rise as much as would have been expected. Land along the canals was an exorbitant $2.50 per acre, the Indians who many whites settlers feared had been relocated to the west, roads had improved, and railroads were established; however, people feared the Black Swamp itself (Kaatz, 1955).

The rate of settlement of the townships of the Black Swamp area coincided with the availability of drained land. In 1859, a law was passed which provided a system of levees and public drainage ditches.

This draining of the land may or may not have improved the prospects for settlement because the taxes levied on the usage of ditches often equalled the cost of the land being drained. Despite this problem, the pattern of drainage in northwestern Ohio as it exists today was established by the end of the 1800's (Winchell, 1874, p. 228; Sherman, 1925, p. 158; Kaatz, 1955). Industry in this newly settled region began with lumbering in the once extensively forested Black Swamp, followed by a tile industry to implement much needed drainage, and then farming and quarrying which persist today (Kaatz, 1955).

The population of white settlers in the Black Swamp area doubled in the 1850's and then doubled again between 1860-1880 such that no township had fewer than seventeen persons per square mile. In the century from 1795-1895, the Black Swamp had been transformed by the white settlers into the most productive farmland in the state at the expense of displacement of the Indians whose lifestyle was one of coexistence with the Black Swamp.

Of the marshes studied, Winous Point Shooting Club has the earliest documented existence of marsh management in northwestern Ohio. The Club was established in 1854 on a narrow strip of land north of the confluency of Mud Creek Channel and the Sandusky River Channel. In the dining room of the clubhouse at Winous Point Shooting Club there hangs a map of the "Hunting and Fishing Grounds at the Winous Point Shooting Club." This map prepared by the Ottawa County engineer, Edgar H. Brennan, represents the culmination of a survey of the club's property in 1894. The marsh was densely vegetated with "rushes, canes, reeds, flag grasses, bull rushes, lilly pads, trees, arrowheads, and

deer tongue." (As an aside, Lowden (1967) lists Deer Tongue as probably Peltandra virginica, but according to Bellrose (1941) deer's tongue is Potamogeton americanus which is a synonym for Potamogeton nodosus). Shown on the map are discontinuous stone walls which were placed throughout the marsh. These early "dikes" do not appear to have been needed to hold water in the marsh or hold water back as the dikes are used today. Theses written by former Ohio State University students (Andrews, 1952; Bednarik, 1953; Meeks, 1963; Thompson, 1964; Lowden, 1967; Urban, 1968) include much information on the vegetation and usage by wildlife of the dikes at Winous Point Shooting Club. Their work will be elaborated later in the discussion.

According to Moseley, the greatest storms of the century took place during the high water levels of Lake Erie from 1857 to 1862, especially August, 1861. Other storms in September, 1878; July and August, 1879; and May, 1903 caused extensive damage to the shoreline. These storms occurred when the level of Lake Erie was above the long-term average of 570.4 ft. (Carter, 1973). Very possibly, these periods of high water levels coupled with the severe storms have resulted in reductions in the density of the vegetation in the marshes along Lake Erie and Sandusky Bay when compared to the intervening periods of low water when the vegetation was dense as shown by Brennen in his map of the marsh at Winous Point Shooting Club in 1894. This sparse to dense pattern of vegetation caused by low to high water levels is similar to the backward and forward movement of the plants along the shores of the marshes on the Erie Islands as observed by Core (1949). Recent severe

northeastern storms have occurred in July, 1943; May, 1946; March, 1952; April, 1966; July, 1969; and November, 1972 (Carter, 1973). Of these, the 1952 and the 1972 storms caused significant damage to the dikes at the marshes studied, damage which resulted in partial loss of the managed marshes themselves.

The earliest records of the Magee Marsh date from 1895. In the summer of 1895, a fire burned most of the land from Turtle Creek in Ottawa County toward Maumee Bay in Lucas County. Extensive tracts of marshland burned along the shore of Lake Erie. Beginning in 1903, John Nicholas Magee, owner of the Ottawa County dredge began dredging marshland along Lake Erie for landowners interested in farming this land. When the landowners could not pay the fees for dredging the land, Magee acquired the land by foreclosure. Magee dredged a channel twenty-four feet wide with a spoil bank fifteen feet high through 4,000 acres of his newly acquired marshland. The drained land was to be utilized for growing crops. Several severe storms shortly after, inundated the land again. Magee leased the land for waterfowl hunting and trapping in the early 1900's. In 1951, the Ohio Department of Wildlife purchased 2,000 acres of the marsh which has been used as a controlled hunting marsh and preserve (Bednarik, 1952). In 1953, the current manager of Magee Marsh, Karl Bednarik, completed a study of the muskrats in Lake Erie marshes. His study (Bednarik, 1953) includes information on the vegetation and use by wildlife of the dikes at Magee Marsh.

Moxley's Marsh in Erie County has the least known history. Erie County was not considered as a part of northwestern Ohio as determined by the Treaty of Greenville in 1795. The western boundary of Erie

County marked the western border of the Connecticut Western Reserve. This area, including Huron County, has special significance in that it is known as the Fire Lands or the Sufferer's Lands. The Sufferers were those inhabitants of Connecticut whose homes were destroyed by Benedict Arnold and the British Army late in the American Revolution (Cherry, 1921, p. 56). Jurisdiction over the Reserve passed to the United States in 1800. In compliance with the Fort Industry treaty, the title for the Fire Lands was acquired from the Indians in 1805 (Sherman, 1925, pp. 79-83). As part of the Greenville treaty, certain tracts of land were ceded by the Indians to the United States for military purposes. One of these tracts included land in northwestern Erie County along the south shore of Sandusky Bay which corresponds to the area of Moxley's Marsh today. This land was abandoned for military purposes in the early 1800's (Sherman, 1925, p. 133, pl. 29). By 1860, one of the first railroads across Sandusky Bay and through the Black Swamp was built through this marshland at Moxley's Marsh. The railroad is still operating today. To my knowledge, published information is not available on the plant or animal communities at Moxley's Marsh.

Construction of Dikes

There have been two phases in the history of the construction of dikes in northwestern Ohio. In the 1800's, drainage canals and levees were constructed to facilitate drainage of the Black Swamp. Subsequently, this phase provided more land for the population which was on the increase. In the 1900's, the motivation behind the

construction of dikes was (and is) the prevention of flooding and the preservation of marshes, specifically for the maintenance of habitats for waterfowl and muskrat. This latter phase, especially the preservation of marshes, has coincided with the cycle of high-low water levels of Lake Erie. During high water periods, water has been pumped out of the diked marshes to provide optimal habitats; during low water periods, water has been pumped onto the diked marshes to optimize the habitats.

When construction of the first artificial marsh was begun by Magee in Ottawa County in 1903, the first dikes (spoil banks along canals and ditches) in northwestern Ohio were constructed. In Paschall, et al (1928, p. 2), the following quotation pertains to Magee Marsh in Ottawa County: "Parts of Carroll, Erie, and Benton Townships lie in the 'pump lands' which are in close proximity to Lake Erie. Here, dikes and ditches have been constructed, and during periods when the lake is at a high level and during periods of heavy rainfall, water is removed by pumping."

It was not until the 1930's, during a low water period of Lake Erie, that dikes were actually utilized to form impoundments for the purpose of retaining water to maintain marsh habitats. By 1934 there were 125 miles of dikes enclosing 30,000 acres of marshland in Lucas and Ottawa Counties (Day, 1934). When high water levels of Lake Erie returned in the 1940's, the dikes were improved to keep out the rising waters. The severe storms of 1951-1952 damaged many costly construction projects (many were privately funded) in the marshes of northwestern Ohio (Bednarik, 1955). Recently, the November, 1972 storm damaged the

outer dikes at Winous Point Shooting Club and Magee Marsh. This damage resulted in a reduction of the vegetation of these marshes. Since 1972, reconstruction of the outer and inner dikes has proceeded at both marshes. The main body of marshland at Moxley's Marsh was not affected severely by the storm of 1972. This marsh is protected on four sides by roads, and is removed from the intensity of the wave action of Sandusky Bay and Lake Erie.

Dikes are constructed from the sediments of the marsh. Today, diesel drag-line dredges are utilized to pile systematically the sediments into a mound, thus forming simultaneously a dike and a ditch. When the sediments at the top of the dike have dried (most dikes have a gradient of moisture from the top to the base), a bulldozer is utilized to shape the dike, achieving a trapezoidal crossection. In the costlier construction projects, limestone or dolomite rock is hauled by truck or barge, and placed on the outer surfaces of the dike. This procedure is known as "rip-rapping." In the 1930's, rock and labor were inexpensive and it was feasible to rip-rap the dikes (Bednarik, 1955). Today, labor costs for usage of drag-lines and for hauling of rock are expensive, such that the rip-rapped outer dikes which were constructed at Magee Marsh and Winous Point Shooting Club in the past two years have cost tens of thousands of dollars per mile. During this study, construction of dikes was a continuous operation at Magee Marsh and Winous Point Shooting Club in 1976 and 1977.

Once a dike has been constructed, various routine maintenance procedures follow. Newly constructed dikes are bulldozed to provide a level top for access to the marsh by vehicle. Topping of a dike involves

the dredging of sediments onto the dike to fill holes, cracks, and breaks. This procedure usually destroys the existing plants. Many dikes are seeded with grasses, Calamagrostis canadensis, Echinochloa crus-galli var. frumentacea, Festuca elatior, Lolium multiflorum, and Phalaris arundinacea. These cover grasses are utilized to provide food and nesting sites for waterfowl and wildlife; also, to stabilize the soil of the dike. When plants on the dikes become too dense or tall, the dike is mowed. This practice tends to result in the maintenance of a cover of herbaceous species. When shrubs and trees become established, access to the marsh over the dry surface of the dike may become impeded. These woody plants are removed by a specially outfitted tractor known as a "brush-hog" or "bush-hog," which effectively thrashes and chops the stems of the plants.

The lengths of the dikes in this study ranged from a few hundred feet to less than three miles. The heights of the dikes above the levels of the surrounding land or water were usually less than ten feet. The widths of the tops of the dikes ranged from fifteen to twenty-five feet; the bases of the dikes, twenty-five to forty feet (up to eighty feet on the rip-rapped dikes).

METHODS OF STUDY

Techniques

During the field season of 1976, a familiarization of the flora was obtained by preparing lists of the plants for each dike. The abundance of each taxon was estimated utilizing the following categories:

Abundant (A) - uniformly distributed throughout the entire length of the dike;

Common (C) - occurring in discrete zones throughout the entire length of the dike, or uniformly distributed throughout approximately one-half of the length of the dike;

Occasional (O) - sporadic occurrences throughout the length of the dike;

Rare (R) - reserved for taxa that were observed only a few times over a considerable distance on the dike;

Locally common (LC) - occurring almost exclusively in a small, defined area on the dike.

The number of uninterrupted growing seasons for the plants on each dike was obtained from the marsh managers at the respective marshes. In most cases, the dikes have existed for many years. Because of needed repairs, the dikes have been rebuilt. Thus, the age of a dike was not always an indication of the age of the flora. To accurately determine the number of uninterrupted growing seasons of the flora, it was always necessary to determine when a given dike had been rebuilt recently.

In the field season of 1977, transects were established on some of the dikes. The data collected from the transects were utilized to compute frequencies and relative densities for the taxa. These quantifications were supplemental to the estimated abundances. When the quantifications and the estimated abundances are shown together in tables, the latter reflects the abundance of each taxon for the entire dike. The transects were 4 ft. (1.22 m.) in width and the length was the width of the dike. A transect usually included the top and both slopes of the dike. From one to six transects were placed on each dike; these were sampled once or twice. Stem counts were made at increments of 1 ft. (0.31 m.) over the length of the transect.

Relative density (modified from Kershaw, 1973, p. 198) expressed as a percentage was computed as:

$$\text{relative density} = \frac{\text{number of stems of a taxon X 100}}{\text{number of stems of all taxa}}$$

For a taxon, the relative densities from all of the transects on a dike were averaged, yielding one mean value for the sample.

The unit of area for computation of the frequency percentages of the species was 4 sq. ft. (0.37 sq. m.) which corresponded to the width of the transect at 1 ft. (0.31 m.) increments. The percentage of increments of occurrence out of the total number of increments on the dike (all transects combined) constituted the frequency. Thus, a frequency of 10% would indicate that the taxon was present in one out of ten of the 4 sq. ft. (0.37 sq. m.) increments along the transect.

Nomenclature is according to Gray's Manual of Botany, 8th Edition (Fernald, 1950), The Monocotyledonae (Braun, 1967), A Manual of Aquatic

Plants (Fassett, 1957), and Vascular Plants of Ohio (Weishaupt, 1971). All of the specimens that were collected are on deposit at the herbarium of The Ohio State University.

Locations and Numbering of the Dikes Studied

During the field season of 1976, lists of taxa and estimated abundances of the taxa were prepared for sixteen dikes arbitrarily numbered 2 to 16. In 1977, six additional dikes numbered 17 to 22 were studied along with six dikes (4, 5, 9, 10, 11, and 13) from the previous year. Of the twelve dikes studied in 1977, transects were placed on the dikes numbered 4, 5, 9, 10, 11, 18, 19, 20, and 21. From the stem counts obtained from these transects, frequency and relative density data for each taxon on the dike were computed.

The dikes numbered 2, 3, 4, 5, 6, 17, 18, 19, and 20 were located at Winous Point Shooting Club (in Bay Township, Ottawa County property only). The locations of these dikes are plotted on Figure 2. The numbers 5 and 6 pertain to the same dike. In 1976, this dike supported floras in two stages of succession (number 5 in the first season of growth and number 6 in the third season of growth). By 1977, the entire dike had been reconstructed, the flora was in the first season of growth again, and the number 5 was retained. Figure 2 was prepared from the Vickery Quadrangle 1969 and the Wightman's Grove Quadrangle of the United States Geological Survey 7.5 Minute Series Topographic Maps for Ohio.

The dikes numbered 13, 14, 15, 16, and 22 were located at Magee

Marsh in Lucas and Ottawa Counties. The locations of these dikes are plotted on Figure 3 which was prepared from the Metzger Marsh Quadrangle 1964 and the Oak Harbor Quadrangle 1967.

The dikes numbered 7, 8, 9, 10, 11, 12, and 21 were located at Moxley's Marsh (Margaretta Township, Erie County). The locations of these dikes are plotted on Figure 4 which was prepared from the Castalia Quadrangle 1969. The name Moxley's Marsh does not appear on the map. The name is known locally; a formal name has not been provided.

Consecutive Growing Seasons of the Floras on the Dikes

The floras of seventeen of the twenty-one dikes studied were in five or fewer years of consecutive growth. The marker of five years coincides with the storm of 1972 and the period of high water which followed for three years. During this period, most of the outer dikes and some of the inner dikes, especially at Magee Marsh and Winous Point Shooting Club, were ravaged by the force of the waves. All of the outer dikes facing Lake Erie and Sandusky Bay were recently reconstructed and have supported plants for fewer than two consecutive growing seasons. As another consequence of the high water, all that had remained of some of the older dikes (those which had supported plants prior to 1972) were isolated patches of the original dike, mostly mudflat only, supporting dead trees or a flora atypical of the actual age of the dike.

Four dikes with floras in excess of ten growing seasons were located

FIGURE 2. A Map of the Study Area at Winous Point Shooting Club Showing the Locations of the Dikes Which Were Studied.

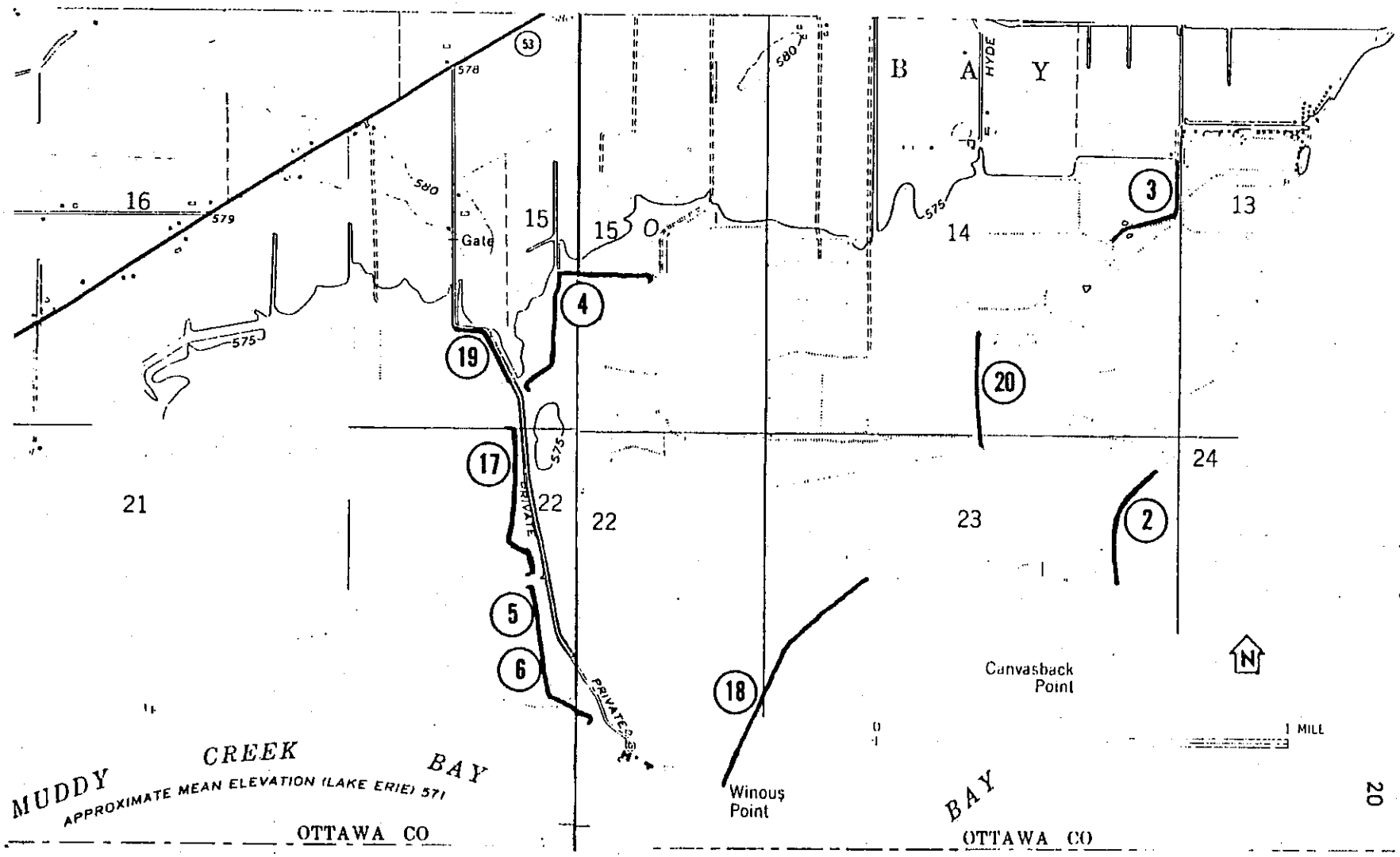


FIGURE 3. A Map of the Study Area at Magee Marsh Showing the Locations of the Dikes Which Were Studied.

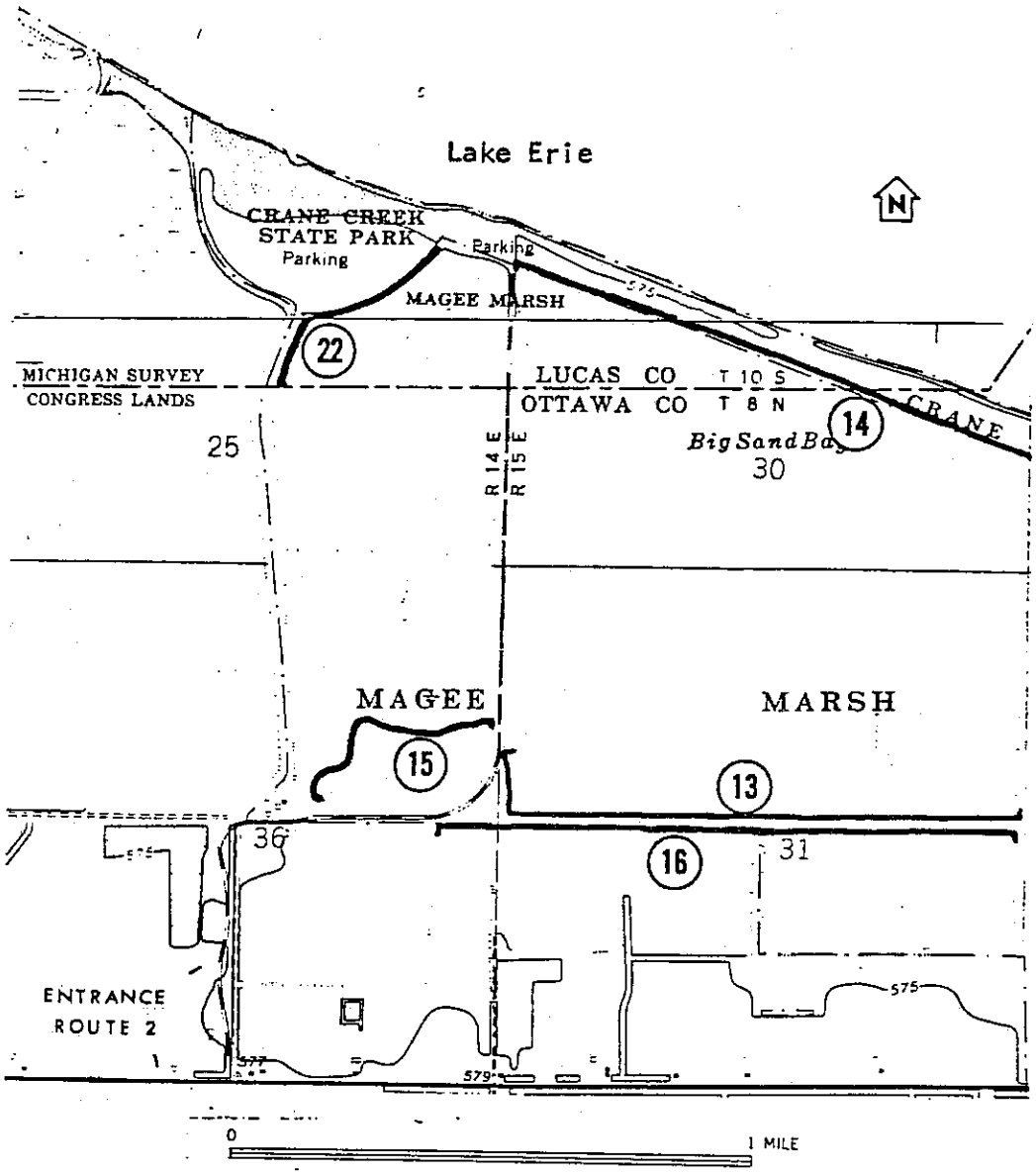
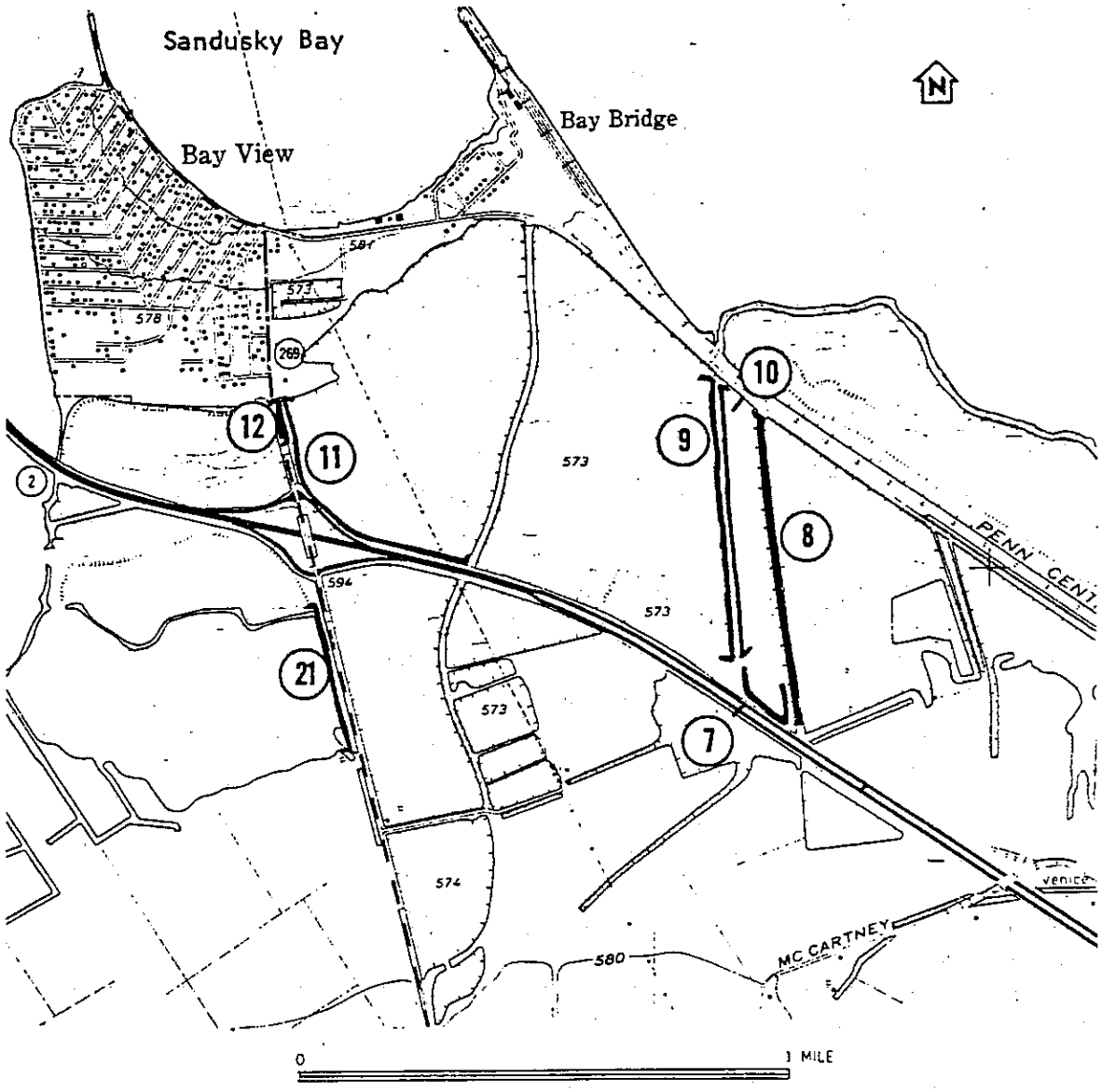


FIGURE 4. A Map of the Study Area at Moxley's Marsh Showing the Locations of the Dikes Which Were Studied.



and studied. These older dikes (numbers 8, 12, 20, 21) were protected from wave damage, hence succession of the plant communities proceeded for a longer period of time. The floras of two of these dikes were in the range of ten to twenty-five growing seasons (the exact age could not be determined), and the floras of the other two dikes were in excess of twenty-five growing seasons. This marker of more than or fewer than twenty-five growing seasons coincides with the storm of 1952 which had affected the dikes similarly as did the storm of 1972.

RESULTS

Estimated Abundances, Frequencies, Relative Densities, and the Catalogue of the Taxa on the Dikes of the Marshes of Northwestern Ohio

Thirty-five lists of taxa were prepared for the twenty-one dikes which were surveyed in this study. The lists are presented as two synopses and Tables A1 to A35 in Appendix A. Each table contains the names and the estimated abundances of the taxa. Where applicable, frequency and relative density percentages have been included as supportive evidence for the estimated abundances. The location of each dike (also refer to Figure 2, 3, or 4), obvious disturbances on the dike, and sources of seeds for the flora of the dike are included as a part of the information in each table.

A catalogue of 196 taxa of vascular plants occurring on the dikes in the marshes of northwestern Ohio was prepared from the tables of Appendix A. The catalogue is presented in Appendix B. Included in this catalogue are the scientific name and the common name for each taxon, the numbers of the dikes and the names of the marshes where the taxon was observed, and the status (indigenous or non-indigenous) of each taxon.

The information in Appendices A and B has been utilized to prepare the commentary and discussion which follow. For example, in a later section, these results have formed the bases for the determination of the succession of the flora of the dikes. In addition, these appendices alone represent a compendium of baseline information which may be utilized for research in the future.

DISCUSSION

Commentary on the Taxa Observed Commonly on the Dikes in the Three Marshes

Winous Point Shooting Club (See Tables 1 and 2)

For complete lists of all taxa and their abundances on the dikes at Winous Point Shooting Club, see Tables A1, A2, A3, A4, A9, A10, A14, A15, A20, A21, A26, A27, A28, A29, and A33 in Appendix A.

Undoubtedly, the most common species on newly constructed dikes was Polygonum lapathifolium, nodding smartweed. In 1977, P. lapathifolium was abundant with a frequency as high as 47% and a relative density as high as 93% on dike 5 (Tables A2, A3, and A4; Figure 5), and especially dike 18 (Tables A9 and A10). There have not been marshes with substantial stands of P. lapathifolium in the vicinity of these dikes for over five years, owing to the storm of 1972 which damaged the outer dikes. The subsequent period of high water in the marsh which followed the storm has persisted even during this study. Therefore, the seeds from which the P. lapathifolium plants on dikes 5 and 18 had germinated, must have been dormant for over five years in the sediments from which these dikes were constructed. In lesser abundance, yet common on almost every newly constructed dike was Polygonum pensylvanicum (interspersed among the P. lapathifolium plants) and Impatiens capensis toward the base of the dike.

Amaranthus retroflexus and Carex sp. were abundant on dike 2 (Table A1) and dike 5 (Table A2), respectively. Overall, these taxa occurred rarely on the dikes at Winous Point Shooting Club. Their occurrence on

TABLE 1. The Taxa Observed Commonly in All Successional Stages at Winous Point Shooting Club; Arranged by Growth Habit.

Herbaceous Annuals and Perennials

Abutilon theophrasti
Acalypha rhomboidea
Amaranthus retroflexus
Asclepias incarnata
Aster simplex

Bidens frondosa
Brassica kaber
Carex sp.
Chenopodium album
Cirsium arvense

Daucus carota
Geum canadense

Hibiscus palustris
Impatiens capensis
Lactuca scariola
Melilotus spp.
Phalaris arundinacea

Polygonum coccineum
Polygonum lapathifolium
Polygonum pensylvanicum
Polygonum punctatum
Sonchus uliginosus

Taraxacum officinale

Vines

Convolvulus sepium
Parthenocissus inserta

Solanum dulcamara

Trees and Shrubs

Cornus drummondii

Salix interior

TABLE 2. The Taxa Observed Commonly in All Successional Stages at Winous Point Shooting Club; Arranged by the Number of Consecutive Growing Seasons.

	Number of Growing Seasons					
Taxa	1	2	3	4	5	10 to 25
Amaranthus retroflexus	X					
Carex sp.	X					
Hibiscus palustris	X					
Polygonum lapathifolium	X	X				
Polygonum pensylvanicum	X				X	
Impatiens capensis	X	X			X	
Polygonum punctatum		X				
Daucus carota		X		X		
Lactuca scariola		X		X		
Polygonum coccineum		X		X		
Salix interior		X		X		
Sonchus uliginosus		X		X		
Cirsium arvense		X		X	X	
Convolvulus sepium		X		X	X	
Melilotus spp.		X		X	X	
Phalaris arundinacea		X	X	X	X	
Abutilon theophrasti				X		
Acalypha rhomboidea				X		
Asclepias incarnata				X		
Aster simplex				X		
Bidens frondosa				X		
Parthenocissus inserta			X	X		
Taraxacum officinale				X		
Cornus drummondii			X	X	X	X
Brassica kaber					X	
Chenopodium album					X	
Solanum dulcamara					X	
Geum canadense						X

FIGURE 5. Newly constructed dike at Winous Point Shooting Club with Polygonum lapathifolium common on slopes.

the dikes was a manifestation of the available seed source in the adjacent marsh.

Hibiscus palustris was evident on all newly constructed dikes. The abundance of this species ranged from occasional to common (see Tables A1, A2, A3, A4, A9, and A10). Low elevation dikes (spoil dikes) constructed as late in the growing season as September supported a dense growth of H. palustris seedlings; these plants probably germinated from seeds which were produced earlier in the growing season.

By the second to the fifth growing seasons (dikes 3, 4, 6, 17, and 19), P. lapathifolium decreased in abundance. Impatiens capensis remained abundant along the bases of the dikes, and Cirsium arvense (see Figure 6) became dominant on the tops and the slopes. Some of the characteristic agricultural and roadside weedy species in the vicinity, including Abutilon theophrasti, Brassica kaber, Daucus carota, Melilotus spp., and Sonchus uliginosus began to be seeded onto the dikes. They shortly became very common, very visible, and formed discrete zones on the tops of the dikes. Also in this stage, the cover grasses which are seeded onto the tops of the dikes as a part of the management program at Winous Point Shooting Club, can become well-established. Phalaris arundinacea was the most abundant cover grass observed, especially on dike 6 (Table A15) in the third season of growth. Convolvulus sepium and Parthenocissus inserta were very common vines, and Vitis riparia was encountered occasionally. Generally, the species diversity at this stage is the highest.

Salix interior and Cornus drummondii were the most abundant woody

FIGURE 6. Dike 19 in the fourth season of growth. Cirsium arvense is abundant. Generally, species diversity is highest at this stage.

species observed. Salix interior was seen frequently as seedlings on newly constructed dikes; however, on dike 19 (Tables A26 and A27) a clone developed. Cornus drummondii was evident throughout the marsh proper, but it existed especially well on the dikes. Seedlings were observed as early as the first growing season on the dikes. Cornus drummondii then increased in dominance throughout the intervening stages of succession, up to a stage of almost complete dominance with a frequency of 72% and a relative density of 52% on dike 20 (Table A33) which was in the range of 10 to 25 seasons of growth. Throughout the marsh, dead cottonwoods and willows were observed on some of the remnants of dikes which were constructed prior to the 1950's.

These findings coincide with those of others who have conducted field studies at Winous Point Shooting Club. Lowden (1969) in his vascular flora of Winous Point listed 76 species occurring on the dikes (see Appendix C). Aside from labeling the species as representative of the dikes, the time of occurrence or abundance on the dikes was absent. Nevertheless, Lowden's list was one of the longest to date and included 18 species not found in this study of the dikes in 1976 and 1977.

As part of a study on waterfowl nesting at Winous Point, Andrews (1952) included observations of the dike flora and a brief history of the construction of dikes. Regarding the dike flora, Andrews noted that the main vegetation of the dikes was a function of the age, location, and elevation of the dike. The first year flora consisted of a dense growth of nodding smartweed. The second year flora included thistle, burdock, jewelweed, squirrel-tail grass, milkweeds, and sedges; these

species replaced the smartweed. In subsequent years, the flora consisted of blue-joint grass, sweet clover, nettles, bindweed, vervain, teasel, indian hemp, bittersweet nightshade, grape, silky dogwood, and elderberry. Andrews noted that these species were not uniformly distributed along the dike. Old dikes along Mud (Muddy) Creek Bay supported small trees of crack willow, black willow, and cottonwood, some which were planted to strengthen the dikes.

In a study of the effects of drawdown date on plant succession in the marsh at Winous Point, Meeks (1963) observed, "Nodding smartweed was the main plant on the new dikes for several years. Canada thistle then became established." He also observed willow saplings to be common on the formerly new dikes, approximately six years after his study began. In time (unspecified period) blue-joint grass replaced Walter's millet and rice-cutgrass along the sides of the dikes.

Thompson (1964) studied waterfowl nesting at Ottawa Shooting Club (adjacent to Winous Point Shooting Club). As "prominent plants on the dikes," he included canary grass, blue-joint grass, thistles, burdock, smartweed, jewelweed, nettle, bittersweet nightshade, buttonbush, red ash, silky dogwood, elderberry, blackberry, and others.

In addition to the flora of the dikes, each dike has a representative fauna which depends partially on the dike itself and the plants on the dike for food and shelter. Andrews (1952) studied 157 waterfowl nests, of which 101 were located on dikes. Of these nests on dikes, only four were successful, and all were terminated by predators or high water. The cover type for the nests of mallard, black duck, and blue-

winged teal included blue-joint grass, cat-tail, sedge, willows, bindweed, nightshade, swamp rose mallow, grape, silky dogwood, thistle, cord grass, blue vervain, Phragmites, goldenrod, nettle, elderberry, smartweed, bulrush, burdock, and/or sweet clover. Dikes with a cover of woody plants were avoided by the birds. Bednarik (1953) in his study at Winous Point observed muskrat feeding on the roots of Rhus typhina, alfalfa (Medicago sativa), burdock (Arctium minus), and bull-thistle (Cirsium lanceolatum), and the bark of Populus deltoides. Bednarik also observed that the muskrats dwelling on the dikes tended to be smaller and travelled more extensively to obtain food, compared to muskrats dwelling in the marsh proper. Urban (1968) in a study of raccoons and waterfowl at Winous Point, recorded 64 of 78 nests of mallard, black duck, and blue-winged teal on dikes. Of these nests, only one was successful; the remainder of the nests were terminated by raccoons, red fox, fox snake, opossum, skunk, mink, and dog.

Moxley's Marsh (See Tables 3 and 4)

For complete lists of all species and their abundances on the dikes at Moxley's Marsh see Tables A12, A13, A16, A17, A18, A19, A22, A23, A24, A25, A32, A34, and A35 in Appendix A.

Dikes with floras in the range of two to four growing seasons, and ten or more growing seasons were represented well at Moxley's Marsh. First growing season dikes were not available for study because most of the major construction of dikes had been completed by 1975.

Polygonum lapathifolium, Abutilon theophrasti, Cirsium arvense, Convolvulus sepium, and Impatiens capensis were common species in the

TABLE 3. The Taxa Observed Commonly in All Successional Stages at Moxley's Marsh; Arranged by Growth Habit.

Herbaceous Annuals and Perennials

Abutilon theophrasti
Asclepias incarnata
Brassica kaber
Calamagrostis canadensis
Carex sp.
Cirsium arvense
Festuca elatior
Hibiscus palustris
Impatiens capensis
Leersia oryzoides
Lolium multiflorum
Panicum capillare
Phalaris arundinacea
Polygonum lapathifolium
Solidago gigantea
Sonchus asper
Verbena hastata

Vines

Convolvulus sepium
Lonicera japonica
Parthenocissus inserta
Solanum dulcamara
Vitis riparia

Trees and Shrubs

Cornus drummondii
Cornus racemosa
Populus deltoides
Ribes americanum
Salix alba

TABLE 4. The Taxa Observed Commonly in All Successional Stages at Moxley's Marsh; Arranged by the Number of Consecutive Growing Seasons.

	Number of Growing Seasons				
Taxa	2	3	4	10	25+
Abutilon theophrasti	X				
Panicum capillare	X				
Leersia oryzoides	X	X			
Polygonum lapathifolium	X	X		X*	
Convolvulus sepium	X	X	X		
Impatiens capensis	X	X	X		X
Cirsium arvense	X	X	X	X	
Hibiscus palustris		X			
Lolium multiflorum		X			
Phalaris arundinacea		X			
Sonchus asper		X			
Brassica kaber		X	X		
Festuca elatior		X	X		
Verbena hastata		X	X		
Asclepias incarnata		X	X	X	
Solanum dulcamara			X		
Calamagrostis canadensis				X	
Populus deltoides				X	
Cornus drummondii				X	X
Carex sp.					X
Cornus racemosa					X
Lonicera japonica					X
Parthenocissus inserta					X
Ribes americanum					X
Salix alba					X
Solidago gigantea					X
Vitis riparia					X

*On the seasonally inundated west slope of dike Number 8.

second season of growth (see Figure 7; Tables A12 and A13). Sources of seeds for these species were plentiful in the marsh, on roadsides and railroad embankments, and in adjacent fields. By the third season (see Tables A16 to A19) of growth, Abutilon theophrasti and Polygonum lapathifolium decreased in abundance, whereupon Asclepias incarnata, Brassica kaber, and Verbena hastata became prominent. Unlike the flora at Winous Point and Magee Marsh, the sweet clovers (Melilotus spp.) were not abundant at this stage, or any other. Cirsium arvense was the dominant species, attaining frequencies of over 44% and relative densities of over 20% on dike 10 (Table A18) and dike 9 (Table A23).

The cover grasses Lolium multiflorum, Festuca elatior, and Phalaris arundinacea were evident in the third to fourth season of growth. Festuca elatior became so abundant on the tops of the dikes that it may have masked partially the natural succession on the dikes (see Figure 8).

Vines occurred profusely on the dikes at Moxley's Marsh. Convolvulus sepium and Solanum dulcamara formed dense entanglements on the dikes in the early stages of succession, and Parthenocissus inserta and Vitis riparia existed likewise on the dikes in the advanced stages of succession. Cuscuta gronovii was occasional on dike 9 (Table A23) and Lonicera japonica was abundant on dike 12 (Table A34). The occurrences of these latter two species were rather opportunistic.

The common woody species were dogwoods (Cornus spp.), cottonwood (Populus deltoides), and willows (Salix spp.). The cottonwoods were dominant at the tenth growing season on dike 8 (Table A34). On dike 12 (Table A34) and dike 21 (Table A35), the shrub canopy consisted of

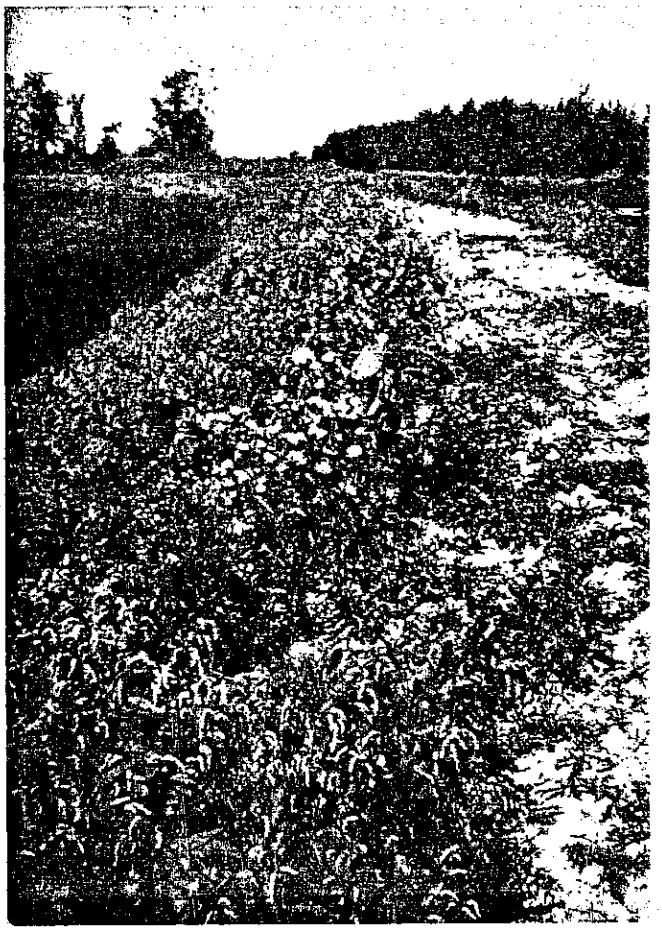


FIGURE 7. Polygonum lapathifolium and Cirsium arvense on Dike 7 at Moxley's Marsh.

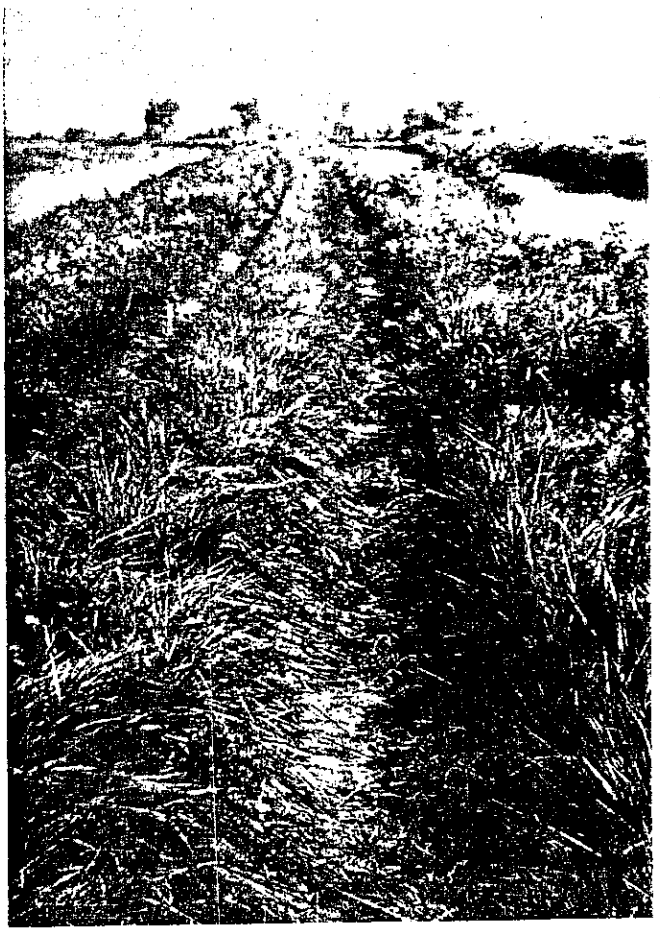


FIGURE 8. *Festuca elatior* seeded on a third year dike (Dike 9) at Moxley's Marsh.

dogwoods and the tree canopy consisted of willows (see Figure 9). By the time succession has proceeded to this stage, the dike itself has usually been breached, animal damage is apparent, repairs are difficult, and the dike is functionless. Many of these old dikes are still visible on the horizon at Moxley's Marsh. (Salix alba was dominant. Very possibly it was planted on the dikes, years ago.)

Magee Marsh (See Tables 5 and 6)

For complete lists of all species and their abundances on the dikes at Magee Marsh see Tables A5, A6, A7, A8, A11, A30, and A31 in Appendix A.

The flora of the dikes at Magee Marsh was not documented as well as the floras at Moxley's Marsh and Winous Point Shooting Club. Only the first and the fifth growing seasons were represented on the dikes which were studied at Magee Marsh. Management practices were evident on the dikes. Nearly all of the dikes have been in existence for many years, yet they have been rebuilt, mowed, brush-hogged, seeded, and/or inundated repeatedly; therefore, the actual number of consecutive growing seasons has been far less than the actual age of the dike. These practices have aided in preserving the dikes, not the natural flora.

At Magee Marsh, the flora of the dikes closely reflected the flora of the marsh and the flora of the shoreline of Lake Erie. Common species on the dikes included Abutilon theophrasti, Amaranthus tuberculatus, Cyperus erythrorhizos, Cyperus ferruginescens, and Polygonum lapathifolium which were also common in the marsh. Echinochloa walteri, an abundant species in the marsh, was observed only occasionally on the dikes.

FIGURE 9. Willows after more than twenty-five seasons of growth on Dike 12 at Moxley's Marsh.

TABLE 5. The Taxa Observed Commonly in All Successional Stages at Magee Marsh; Arranged by Growth Habit.

Herbaceous Annuals and Perennials

Abutilon theophrasti
Acalypha rhomboidea
Amaranthus tuberculatus
Arctium lappa
Asclepias incarnata
Atriplex patula var. hastata
Bidens cernua
Brassica kaber
Calamagrostis canadensis
Cirsium arvense
Cyperus erythrorhizos
Cyperus ferruginescens
Euphorbia maculata
Euphorbia supina
Festuca elatior
Hibiscus trionum
Impatiens capensis
Leersia oryzoides
Lycopus americanus
Lycopus europaeus
Melilotus alba
Panicum capillare
Polygonum aviculare
Polygonum coccineum
Polygonum lapathifolium
Polygonum pensylvanicum
Sonchus sp.

Vines

Convolvulus sepium
Strophostyles helvola

Trees and Shrubs

Cornus drummondii
Populus deltoides
Rhus glabra
Rhus typhina
Salix fragilis

TABLE 6. The Taxa Observed Commonly in All Successional Stages at Magee Marsh; Arranged by the Number of Consecutive Growing Seasons.

	Number of Growing Seasons	
Taxa	1	5
Amaranthus tuberculatus	X	
Acalypha rhomboidea	X	
Arctium lappa	X	
Asclepias incarnata	X	
Atriplex patula var. hastata	X	
Bidens cernua	X	
Convolvulus sepium	X	
Cyperus erythrorhizos	X	
Euphorbia maculata	X	
Euphorbia supina	X	
Hibiscus trionum	X	
Leersia oryzoides	X	
Panicum capillare	X	
Polygonum aviculare	X	
Polygonum coccineum	X	
Polygonum pensylvanicum	X	
Sonchus sp.	X	
Strophostyles helvola	X	
Abutilon theophrasti	X	X
Brassica kaber	X	X
Cirsium arvense	X	X
Cornus drummondii	X	X
Cyperus ferruginescens	X	X
Polygonum lapathifolium	X	X
Populus deltoides	X	X
Calamagrostis canadensis		X
Festuca elatior		X
Impatiens capensis		X
Lycopus americanus		X
Lycopus europaeus		X
Melilotus alba		X
Rhus glabra		X
Rhus typhina		X
Salix fragilis		X

Atriplex patula var. hastata, Euphorbia maculata, Euphorbia supina, and Polygonum aviculare were abundant on dike 14 (Table A7) and dike 22 (Table A11) adjacent to the sandy shoreline of Lake Erie. Conspicuously absent from these two dikes was Xanthium strumarium which occurred abundantly along the shoreline.

Cirsium arvense was common in areas of recent disturbance, especially if the disturbance occurred late in the summer as on dike 13 (Table A6). On this dike, only rosettes of Canada thistle were present; very possibly these plants grew from germinated seeds which had been produced earlier in the summer.

Brassica kaber and Melilotus alba formed conspicuous zones in the first season of growth on some of the dikes. Less conspicuous, but equally abundant were Hibiscus trionum (exclusively on the top of the dike), Impatiens capensis (at the base of the dike), and the water horehounds (Lycopus spp.).

The common species of woody plants were Cornus drummondii, Populus deltoides, Rhus glabra, Rhus typhina, and Salix fragilis. The dogwoods and the sumacs existed in thickets, mostly on the slopes of the dikes (most of this type of brush was removed from the tops of the dikes).

An Analysis of the Distribution of the Plants by: Disturbance of the Habitat, Duration of the Species, Position on the Dike, Soil Moisture Gradient, and Status in the Flora

Inherent to the structure of a dike is the gradient of the moisture of the soil from drier at the top to moist toward the base (saturated if the base is submerged). A manifestation of this gradient is a

pattern in plant distribution. The species of terrestrial habitats tend to occur at the top of the dike, the species of wetland habitats tend to occur toward the base, and some species span the entire gradient.

The species catalogued for this study are grouped accordingly: species of the upper, drier habitat of the dikes (Table 7); species occupying the upper to the lower habitat (Table 8); and species of the sides and the lower, moist habitat (Table 9). Within each of these groupings, the species are arranged primarily by status, as indigenous or non-indigenous, and secondarily by duration as annuals, biennials, or perennials.

In addition to less moisture at the top of the dike, this area is more susceptible to disturbances by man, especially mowing and vehicular traffic. This habitat is not unlike the habitats of the roadside "weeds" and the agricultural "weeds" in the vicinity of the marshes. Seventy-eight species (44% of the total flora) occupied, almost exclusively, the upper, drier, terrestrial habitat of the dikes. These species are listed in Table 7. Of these 78 species, 43 species (55%) are non-indigenous of which 34 species (19% of the total flora) were annuals and biennials. Abutilon theophrasti, Brassica kaber, Daucus carota, and Melilotus spp. are very common species from within this grouping, especially on dikes with floras in the second to the fifth season of growth. Festuca elatior and Salix alba are the only common non-indigenous perennials in this grouping. The remaining 45% of the species in Table 7 are the indigenous annuals, biennials, and perennials occurring on the tops of the dikes. As opposed to the non-indigenous

TABLE 7. Grouping of 78 Species on the Upper, Drier Habitat of the Dikes.

Indigenous (35 species, 45% of this grouping, 20% of the total flora)

Annuals and Biennials
(18 species, 23% of this grouping, 10% of the total flora)

Acalypha rhomboidea
Atriplex patula var. hastata
Atriplex patula var. patula
Eragrostis pectinacea
Erechtites hieracifolia
Erigeron annuus
Erigeron strigosus
Euphorbia maculata
Euphorbia serphyllifolia
Euphorbia supina
Galium tinctorium
Geum canadense
Lepidium virginicum
Panicum capillare
Panicum dichotomiflorum
Plantago rugellii
Polanisia dodecandra
Rorippa palustris var. hispida

Perennials
(17 species, 22% of this grouping, 10% of the total flora)

Apocynum cannabinum
Circaea quadrisulcata
Cornus racemosa
Eragrostis hypnoides
Eupatorium perfoliatum
Panicum lanuginosum
Physalis virginiana
Phytolacca americana
Poa pratensis
Polygonum scandens
Rhus radicans
Ribes americanum
Salix amygdaloides
Salix rigida
Solanum carolinense
Triosteum perfoliatum
Verbena urticifolia

Non-Indigenous (43 species, 55% of this grouping, 24% of the total flora)

Annuals and Biennials
(34 species, 44% of this grouping, 19% of the total flora)

Abutilon theophrasti
Alliaria officinalis
Amaranthus albus
Amaranthus graecizans
Amaranthus retroflexus
Arctium lappa
Arctium minus
Barbarea vulgaris
Brassica kaber
Carduus nutans
Chaenorrhinum minus
Chenopodium album
Cirsium vulgare
Daucus carota
Digitaria sanguinalis
Dipsacus sylvestris
Hibiscus trionum
Hordeum jubatum
Lepidium campestre
Lolium multiflorum
Lycopersicon esculentum
Melilotus alba
Melilotus officinalis
Polygonum aviculare
Rumex maritimus
Setaria faberii
Setaria glauca
Setaria viridis
Taraxacum officinale
Thlaspi arvense
Tragopogon major
Tragopogon pratensis
Verbascum thapsus
Xanthium strumarium

Perennials
(9 species, 11% of this grouping, 5% of the total flora)

Dactylis glomerata
Festuca elatior
Lonicera japonica
Mirabilis nyctaginea
Physalis alkekengi
Rorippa sylvestris
Rosa multiflora
Salix alba
Trifolium repens

TABLE 8. Grouping of 35 Species Occupying the Upper to the Lower Habitats of the Dikes.

Indigenous (25 species, 71% of this grouping, 14% of the total flora)

Annuals and Biennials
(7 species, 20% of this grouping, 4% of the total flora)

Ambrosia artemisiifolia
Ambrosia trifida
Bidens frondosa
Echinochloa pungens
Oenothera biennis
Oxalis europaea
Polygonum pensylvanicum

Perennials
(18 species, 51% of this grouping, 10% of the total flora)

Asclepias incarnata
Asclepias syriaca
Aster simplex
Calamagrostis canadensis
Convolvulus sepium
Cornus drummondii
Cuscuta gronovii
Elymus virginicus
Gleditsia triacanthos
Hibiscus palustris
Parthenocissus inserta
Phalaris arundinacea
Phragmites australis
Polygonum coccineum
Rhus typhina
Salix interior
Verbena hastata
Vitis riparia

Non-Indigenous (10 species, 29% of this grouping, 6% of the total flora)

Annuals and Biennials
(4 species, 12% of this grouping, 2% of the total flora)

Lactuca scariola
Medicago lupulina
Rumex crispus
Sonchus asper

Perennials
(6 species, 17% of this grouping, 4% of the total flora)

Cichorium intybus
Cirsium arvense
Salix fragilis
Solanum dulcamara
Sonchus uliginosus
Trifolium pratense

TABLE 9. Grouping of 65 Species of the Sides and the Lower, Moist Habitat of the Dikes.

Indigenous (53 species, 82% of this grouping, 29% of the total flora)

Annuals and Biennials
(15 species, 23% of this grouping, 8% of the total flora)

Amaranthus tuberculatus
Bidens cernua
Bidens connata
Cyperus erythrorhizos
Cyperus ferruginescens
Eclipta alba
Gaura biennis
Impatiens capensis
Pilea pumila
Polygonum hydropiper
Polygonum lapathifolium
Ranunculus abortivus
Ranunculus sceleratus
Sicyos angulatus
Strophostyles helvola

Perennials
(38 species, 58% of this grouping, 21% of the total flora)

Acer negundo
Acer saccharinum
Alisma plantago-aquatica
Aster novae-angliae
Celtis occidentalis
Cyperus esculentus
Cyperus strigosus
Epilobium glandulosum
Fraxinus pennsylvanica
Helenium autumnale
Leersia oryzoides
Ludwigia palustris var. americana
Lycopus americanus
Lysimachia ciliata
Mentha arvensis
Mimulus ringens
Penthorum sedoides
Polygonum punctatum
Populus deltoides
Quercus borealis
Quercus palustris
Rhus glabra
Sagittaria latifolia
Sambucus canadensis
Scirpus fluviatilis
Scirpus validus
Scutellaria epilobiifolia
Scutellaria lateriflora
Smilacina stellata
Solidago gigantea
Solidago nemoralis
Sparganium eurycarpum
Stachys tenuifolia
Teucrium canadense
Thalictrum dasycarpum
Typha angustifolia
Typha latifolia
Ulmus rubra

Non-Indigenous (12 species, 18% of this grouping, 6% of the total flora)

Annuals
(4 species, 6% of this grouping, 2% of the total flora)

Echinochloa crus-galli
Echinochloa walteri
Ipomoea purpurea
Polygonum persicaria

Perennials
(8 species, 12% of this grouping, 4% of the total flora)

Epilobium hirsutum
Lotus corniculatus
Lycopus europaeus
Lysimachia nummularia
Lythrum salicaria
Mentha piperita
Nepeta cataria
Solanum nigrum

species (some were common), the indigenous species were observed only occasionally or rarely on the tops of the dikes.

The 35 species in Table 8 represent a segment of the flora which was observed almost as often on the tops, sides (slopes) and bases of the dikes. In contrast to the previous grouping (Table 7), the largest segment of this grouping (51%) is composed of the indigenous perennials. Common species in this segment include Asclepias incarnata, Convolvulus sepium, Cornus drummondii, Hibiscus palustris, Parthenocissus inserta, Phalaris arundinacea, Salix interior, and Vitis riparia. Each of these species is distributed widely, occurring on many dikes in many stages of succession. Only 7 species of indigenous annuals and biennials are present in this grouping. Occasionally, one or more of these species predominates on a dike.

The non-indigenous complement in Table 8 is composed of 10 species (29% of this grouping). The most significant aspect of this segment is the presence of Cirsium arvense and Solanum dulcamara, both "weedy" perennials. Solanum dulcamara was an abundant vine on the tops and slopes of the dikes, especially at Moxley's Marsh where occasionally this species forms a dense entanglement of plants. Cirsium arvense is the most abundant species. It occurred on 19 of the 21 dikes, regardless of the stage of succession of the flora.

In Table 9, 65 species represent 35% of the total flora. These species are associated with the sides and the lower, moist habitats of the dikes. Most of these species are considered to be aquatic or wetland plants of naturally-distributed habitats including mudflats, beaches,

and marshes. Impatiens capensis and Polygonum lapathifolium are the dominant indigenous, annual, wetland species of the dikes. The indigenous perennials constitute 58% (21% of the total flora); however, only Populus deltoides was of common occurrence. Most of the remaining indigenous perennials were observed only rarely or occasionally. Eleocharis, Juncus, and Scirpus which are common, indigenous genera of wetlands or in the marshes, were conspicuously absent from the dikes, or occurred only rarely. Within this grouping, only 18% of the species are non-indigenous, the lowest percentage of non-indigenousness when compared with the percentages of the otner groupings. These non-indigenous species were observed only rarely or occasionally in the flora.

Analysis of the Non-Indigenous Taxa

The Kellermans in 1900 prepared one of the first lists of non-indigenous plants of Ohio. Of the 2,060 species known to occur in Ohio at that time, 460 species (approximately 21%) were non-indigenous. Included in this list are Abutilon abutilon [Abutilon theophrasti], Brassica arvensis [Brassica kaber], Carduus arvensis [Cirsium arvense], Daucus carota, Festuca elatior, Melilotus spp., Salix spp., and Solanum dulcamara, which are representative of the common non-indigenous species on the dikes in northwestern Ohio. Polygonum lapathifolium, also common on the dikes, is listed by the Kellermans as native to Europe; according to Fernald (1950) this species occurs in North America and Europe, not naturalized from Europe. The Kellermans also included a list of "native weeds," supposedly to clarify that "[not] all of our bad weeds are of old world origin." Some of these

"native weeds" listed as common species by the Kellermans, were observed currently to be common to the dikes. They are Ambrosia spp., Asclepias incarnata, Atriplex hastata [Atriplex patula var. hastata], Bidens frondosa, Convolvulus repens [Convolvulus sepium], Panicum capillare, Polygonum pennsylvanicus [Polygonum pensylvanicum], and Rhus glabra. More recently, Marshall (1977) in a comparison of non-indigenous aspects of the Ohio flora has tallied 599 species (24%) as non-indigenous species in Vascular Plants of Ohio by Weishaupt (1971). This is an increase of 139 species since 1900. An interesting comparison would be to determine if a higher percentage of these 139 species have become naturalized in man-disturbed habitats or naturally-disturbed habitats. Very possibly it would be the former, because of the tremendous increase in disturbance by man of nearly all habitats.

Of the 178 species on the dikes which are listed in Appendix B, 65 (36%) are non-indigenous to the Ohio flora. This is considerably higher than the percentage for the state. Most of these non-indigenous species have become naturalized into the flora of North America from Europe and Eurasia. Their introduction into North America began at the time of colonization of the New World by the Europeans. Many of these species are now associated commonly with man-disturbed habitats which include roadsides, gardens, agricultural land, and the dikes in the managed marshes of northwestern Ohio.

In Tables 7, 8, and 9, it was shown that the flora of the dikes could be compartmentalized on the basis of moisture gradient. In terms of the non-indigenous aspect of this compartmentalization, 55% of the

species at the tops of the dikes (terrestrial, dry habitat) were non-indigenous, 29% of the species from the tops to the bases (dry to wet habitat) were non-indigenous, and 18% of the species at the lower, moist bases (wet habitat) were non-indigenous. This range of from 55% to 18% non-indigenousness of the flora is much more significant than the 36% non-indigenousness of the total flora of the dikes. This range has two implications: 1) the rate of replacement of the flora in the dry, terrestrial, man-disturbed habitats has proceeded more rapidly than the rate of replacement of the flora in the wetland, naturally-disturbed habitats; 2) the reason for the high percentage of non-indigenousness of the flora of the dikes in general is the high percentage of non-indigenousness among the species at the tops of dikes.

These findings are in accordance with those of Stuckey (1975). In his study of the marsh at the Perry's Victory Monument on South Bass Island in Ottawa County, Ohio, 36% of the 128 species were non-indigenous. He also compartmentalized the species on the basis of a moisture gradient, and thus arrived at a range of non-indigenousness for the flora of the Perry's Victory Monument Marsh (PVMM). The range was from 61% in the category of "Lawn and roadside plants" to 12% in the category "Aquatic and marsh species." A comparison of this study with that of the dikes is presented in Table 10.

In support of the comparison in Table 10, the following information is available from additional floristic studies in northern Ohio. In a study of the flora of fallow vineyards on South Bass Island in Ottawa County, Ohio, Stuckey (1978) recorded 91 of 182 species (50%) as non-indigenous and representative of the terrestrial, dry, man-disturbed

TABLE 10. A Comparison of the Range of Non-indigenousness for the Flora of the Dikes with the Flora of the Perry's Victory Monument Marsh (PVMM), Including Mean Values from Additional Floristic Studies in Northwestern Ohio.

HABITAT	SOIL MOISTURE	% NON-INDIGENOUSNESS OF THE FLORA		
		DIKES (See Tables 7, 8, and 9)	PVMM (Stuckey, 1975)	ADDITIONAL STUDIES
Terrestrial, Dry	Low	Tops of Dikes 55% 43 of 78 species	Lawn and Roadside Plants 61% 31 of 51 species	Fallow Vineyards on South Bass Island (Stuckey, 1978) 50% 91 of 182 species
Average of All Habitats or Species Occur in Both Dry and Moist Habitats	Medium	Tops to Bases of Dikes 29% 10 of 35 species	Species of Both Wet and Dry Habitats 47% 8 of 17 species	Winous Point (Lowden, 1967) 27%, 97 of 364 species Old Woman Creek (Marshall, 1977) 26%, 71 of 273 species Dikes, all habitats (from this study) 36%, 65 of 178 species PVMM, all habitats (Stuckey, 1975) 36%, 46 of 128 species
Wetland, Moist	High	Bases of Dikes 18% 12 of 65 species	Aquatic and Marsh Plants 12% 7 of 60 species	Marsh and Aquatic Vascular Flora of East Harbor (Moore, 1976) 9% 18 of 192 species

habitat.

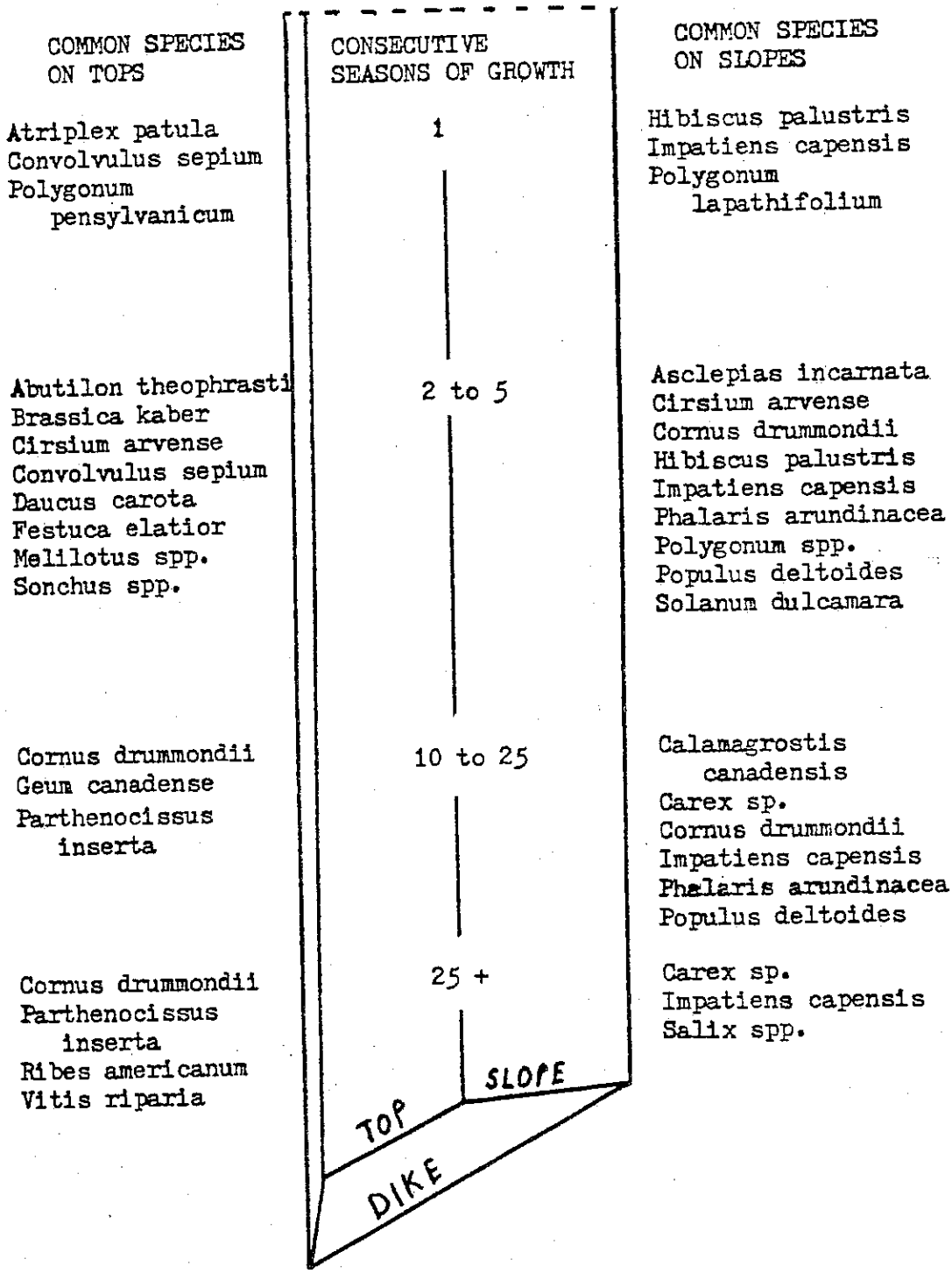
Lowden (1967) in his flora of Winous Point has indicated 27% of the 364 species of this marsh as non-indigenous. Marshall (1977) in his flora of the Old Woman Creek Estuary has indicated 26% of the 273 species as non-indigenous. These two percentages are actually mean values of the non-indigenousness in all habitats of the marsh and of the estuary. They are more closely allied with the mean values of non-indigenousness of the dikes (36%) and Perry's Victory Monument Marsh (36%). These values support the percentages of non-indigenousness of the species which occur in both wet and dry habitats on the dikes and at PVMM (29% and 47% respectively).

In a study of the marsh and aquatic vascular flora at East Harbor State Park, Moore (1976) catalogued 192 species; only 18 (9%) were non-indigenous. This lower percentage for non-indigenousness in the aquatic and marsh habitat coincides with the lower percentages of non-indigenousness in the wetland habitats on the dikes (18%) and in the similar habitat at PVMM (12%).

General Succession of the Plant Communities on the Dikes in Northwestern Ohio

The flora of each dike is unique, yet trends in the succession of plant communities do exist. A generalized succession of the plant communities on the dikes (see Figure 10) was prepared partially from the lists of common species in the marshes (see Tables 1, 2, 3, 4, 5, and 6). In the center of Figure 10, there is a drawing of a hypothetical dike. The consecutive seasons of growth are superimposed over the dike, as if

FIGURE 10. Generalized Succession of the Plant Communities on the Dikes in Northwestern Ohio



this dike supported plant communities in all stages of succession. The common species occurring on the tops and slopes (as a function of the time continuum) are listed to the side of this hypothetical dike.

In the first season of growth, Atriplex patula, Convolvulus sepium, and Polygonum pensylvanicum are common on the top. The frequencies and relative densities of these species are low; nevertheless, the plants are conspicuous. Along the slopes, Hibiscus palustris can be common on dikes. Polygonum lapathifolium is common mostly on the dikes in those marshes which in previous years have had much of this species in the flora. Impatiens capensis is a common species, not only in the first season of growth, but remains common even on the older dikes. It occupies the lowest position on the dike near the water and is continually subjected to natural disturbances.

From the second to the fifth season of growth, the flora is variable from dike to dike. It is during this stage of succession that the flora of the dikes most closely reflects the flora of the surrounding plant communities. Hence, the highest diversity of species can be found on dikes which are in this stage of succession. "Weedy" annuals and biennials including Abutilon theophrasti, Daucus carota, and Melilotus spp. are common. Cirsium arvense, a perennial, appears to be abundant everywhere at this stage. Convolvulus sepium and Solanum dulcamara are the common vines; they will become less abundant in the following stages. The common woody species, only seedlings at this stage, are Cornus drummondii, Populus deltoides, and Salix spp. (occasionally).

The succession of plant communities in the 6 to 10 year range is not known, because dikes in this range were not available for study. Presumably, the flora would be transitory between the 2 to 5- and the 10 to 25-year stages.

By the 10 to 25-year stage, Cornus drummondii and Populus deltoides are common. The dogwoods shade-out effectively most of the herbaceous species, except for Geum canadense which is conspicuous in the absence of the other species. Carex spp. and Impatiens capensis occupy the moist positions along the lower slopes. A common grass along the lower slopes is Calamagrostis canadensis, although this species may be replaced by Phalaris arundinacea.

In the advanced stages of succession as in the twenty-fifth growing season and beyond, the woody species including Cornus spp. (Cornus drummondii predominantly), Populus deltoides, and Salix spp., are dominant, as are the woody vines, Parthenocissus inserta and Vitis riparia. However, even on these older dikes, a zone of herbaceous species exists along the lower slopes near the water level of the ditch (if present). Impatiens capensis will occur commonly in this position, as will the genera Bidens, Carex, and Polygonum, and other species of wetland plants. This herbaceous plant community at the base of these older dikes is more similar to the herbaceous plant communities occurring in the earlier stages of succession. On the older dikes, it is not unusual to find more than one stage of succession of the plant communities (see Figure 11).

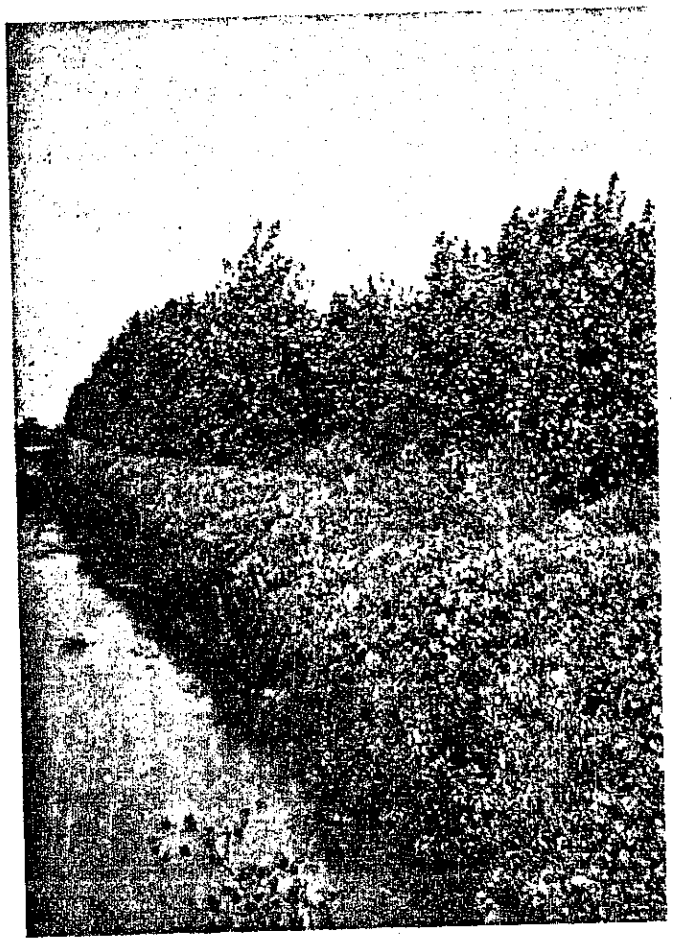


FIGURE 11. Populus deltoides in the tenth season of growth and Polygonum lapathifolium in the first season of growth on Dike 8 at Moxley's Marsh.

Studies of the Floras on Dikes in the Netherlands and Elsewhere in North America

The literature on the floras of dikes is not extensive. Only a few studies in a wide range of locations in North America have been performed. Studies of dikes have been performed in the Netherlands; however, most of these were beyond the scope of this paper and/or they were written in the Dutch language and no attempt was made to have them translated.

Five studies of the floras of dikes (and levees) were reviewed. Many similarities to the floras of the dikes of northwestern Ohio were included in the discussion which follows; however, it should be realized that most of the dissimilarities were not included.

In a study of plant succession on levees in the Illinois River valley, Turner (1931) located and prepared lists of plants for levees ranging in age from one to forty years. These levees were much larger than the dikes of northwestern Ohio. In the first and second years, among the first ranked (in order of abundance) species were Amaranthus spp. and Chenopodium spp., and among the second ranked species was Polygonum lapathifolium. Seedlings of eleven species of woody plants were observed to be common. These included Populus deltoides, Rhus glabra, and Salix spp. In the third to sixth years, the trees began to shade the herbaceous plants on the upper parts of the levees. Convolvulus sepium was among the sixteen species on the upper parts of the levees. Immediately above the water line of the levee, the pioneer community remained.

In the third stage (six to ten years), Turner noted that the shrub cover of sumac, willow, and cottonwood had increased. Forest vines and herbs also had increased concomitantly. In subsequent stages up to forty years, a forest of predominantly Ulmus americana and Acer saccharinum had developed. It was at this point that the similarities to the flora of the dikes of northwestern Ohio ended. The levees were considerably larger than the dikes and could support a mature forest; and they were less susceptible to short-term changes in the flora, changes which could be induced by man-disturbances and natural-disturbances.

For four consecutive years, Thone (1915, 1916, 1917, 1918) studied the succession of plants on a new levee near the Des Moines River in Des Moines, Iowa. The substrate of the levee was composed mostly of sand. He categorized many of the species on the bases of position on the levee, sources of propagules (especially for the first season of growth), and the status of the species.

In the first season of growth, fifty-six species were catalogued. Six species of trees including Salix alba and Populus deltoides were observed. Many of the other first year plants were annuals and biennials. The most common species were Amaranthus retroflexus and Chenopodium album. Regarding the sources of seeds, Thone noted that many of the plants grew from seeds which were wind-blown. Some of the species, especially the woody species started as stem and root fragments.

By the second year, most of the levee had been restructured, and only a small part of the original flora had been preserved. On the

remaining tract, Chenopodium album replaced Amaranthus retroflexus. Fourteen species were added to the flora this year. By the third year, Lactuca scariola and to a lesser extent Ambrosia trifida and Erigeron canadense had replaced Chenopodium album. By the fourth year, many species were observed commonly. Of the fifty-six species observed in the first year, thirty-one species were still observed in the fourth year.

In a comparison of Thone's investigation to the study of the flora of the dikes of northwestern Ohio, certain similarities exist. An annual species dominated in the first year (Amaranthus retroflexus vs. Polygonum lapathifolium). In subsequent years, the first year dominants were replaced by a few annual or perennial "weeds." Of the seventy species catalogued by Thone for the first and second seasons of growth, forty-two species were observed on the dikes of northwestern Ohio.

Brown (1929) studied a levee along the Mississippi River south of Baton Rouge, Louisiana. The levee was considerably larger than any of the dikes studied. Over seventy-five species were catalogued from this levee; however, only five of these species were observed on the dikes of northwestern Ohio. In a comparison of the two studies, the dissimilarities exceeded the similarities. This can probably be accounted for on the bases of the larger size of the levee in relation to the dikes, and the preponderance of species of southern affinity on the levee.

In Ganong's (1903) study of the Bay of Fundy salt and diked marshes, a "distinct zonation" of species was observed on the dike faces. Ganong commented that the dikes became salt-free very rapidly because of

Regarding the flora of the dikes, Beeftink observed Cirsium arvense and Solanum dulcamara to the common on the outside of the sea-dikes where the salinity was low. Atriplex hastata, Cirsium arvense, Solanum dulcamara, Epilobium hirsutum, and Rumex crispus were among the species which occurred mainly on tidal drift (debris) which was washed against the dike faces of the sea dikes.

In general, the vegetation on the dikes of south-west Netherlands varied by substrate (sand vs. clay), age of the dike, the extent of grazing and mowing, and the ranges of salinity concentration along the length and height of the dike. Beeftink provided the following conclusions: where human influence is slight, a mosaic of tall herbs and shrubs develops; mowing promotes tall herbs; grazing favors, among others, Poa pratensis and Trifolium repens; burning promotes Daucus carota and other umbellifers; and planting with poplars reduces the species composition to a minority and will induce Cirsium arvense.

A few of the similarities of Beeftink's study and the study of the dikes of northwestern Ohio have been included, but it should be realized that there were more dissimilarities than similarities, especially in the species composition. His generalizations and conclusions of the ecology of the dikes do to a great extent apply to dikes in a wide range of locations throughout the world, as many of them have applied to the dikes of northwestern Ohio.

SUMMARY AND CONCLUSIONS

The physiographic feature known as the Lake Plain of northwestern Ohio was formed as a result of the most recent glaciation (during the Late Wisconsin state of the Pleistocene Epoch) and the presence of a series of postglacial lakes prior to Lake Erie. Characteristically, the land of the Lake Plain is flat and drainage is poor. Prior to the 1800's, prominent features of the Lake Plain were the virtually uninhabited Black Swamp and the Lake Erie Marshes. Resettlement of the Indians, newly constructed roads, and an extensive drainage system, opened the Black Swamp for colonization in the 1800's. Ironically in the 1900's, dikes were constructed along the shores of Lake Erie and Sandusky Bay to prevent flooding of the newly drained land, and also to preserve the marshland. Subsequently, dikes have been constructed to reclaim marshland for agricultural use, to create habitats for wildlife and waterfowl, and to perpetuate marshes during periods of high and low water levels of Lake Erie and Sandusky Bay. However, prior to this study, few studies of the flora of these dikes had been conducted.

The study area included twenty-one dikes at Winous Point Shooting Club, Moxley's Marsh, and Magee Marsh. For two summers, the vascular flora was surveyed. Lists of plants (and their estimated abundances) were prepared for each dike, and the number of consecutive growing seasons of the flora was determined. These results are tabulated in Appendices A and B. These appendices represent a compendium of baseline information on the flora of the dikes of northwestern Ohio.

The flora of the dikes is analyzed for species composition,

occurrence of common species, succession of plant communities, distribution of species, and the range of non-indigenousness.

The species composition of 194 taxa includes 178 identifiable species and varieties, and 16 genera in vegetative state. A commentary on the occurrence of the common species on the dikes in each of the marshes is presented. While only the common species are discussed, the species of lesser abundance which are not discussed are also included in the tables in Appendix A. The commentary on the occurrence of common species forms the basis for the study of the succession of plant communities on the dikes.

The succession of plant communities on the dikes begins with Polygonum lapathifolium predominantly on the newly constructed dikes. The plants grow from seeds which have been dormant in the sediments from which the dikes are constructed.

In the second to fifth seasons of growth, the species diversity is highest and the flora of the dikes reflects closely the species composition of the surrounding plant communities. "Weedy" species predominate at this stage. Cirsium arvense is the most abundant species.

The tenth to the twenty-fifth (and beyond) seasons of growth are characterized by woody species, including Cornus spp. (Cornus drummondii, predominantly), Populus deltoides, and Salix spp. Zones of herbaceous wetland species occur frequently at the bases near the water. Fluctuating levels of the water provide a continually disturbed habitat which these plants colonize.

The moisture gradient that exists from drier at the top of the dike

to moist toward the base of the dike makes it possible to analyze the floristic components of the dry habitat, the wet habitat, and a combination of the two habitats. A grouping of 78 species occur almost exclusively at the top of the dike. This grouping consists of terrestrial species of which 52 species are annuals and biennials of man-disturbed habitats. Non-indigenous species comprise 55% of this grouping.

The second grouping consists of 35 species occurring almost as often on the tops, slopes, and bases of the dikes. Indigenous perennials, including Cornus drummondii, constitute 51% of the species in this grouping. The non-indigenous species comprise 29% of this grouping; Cirsium arvense, the most abundant species in this study, is one of these species.

The third grouping of 65 species, represents the wetland species on the dikes, mostly occurring on the slopes and the lower, moist habitats. Indigenous perennial species constitute 58% of this grouping; however, only Populus deltoides is common. Only 18% of the species in this grouping are non-indigenous.

Of the 178 species included in this flora, 36% (65 species) are non-indigenous. More significant is the range of non-indigenousness from 55% of the species in the terrestrial habitat at the top of the dike to 18% of the species in the wetland habitat at the base of the dike. The percentage of the non-indigenous flora decreases as the disturbance of the habitat shifts from man to natural, as the soil moisture gradient shifts from dry to moist, and as the species composition of the flora shifts from terrestrial to wetland. A study of the non-indigenous species in the stages of succession was not attempted. The latter

stages of succession are not represented sufficiently for this type of comparison.

Based partially on the similarities gleaned from studies of the floras of dikes throughout the world, the following conclusions are stated for the floras of dikes in general, but in particular for the flora of the dikes of northwestern Ohio.

1) Annual species associated with wetland habitats predominate in the first season of growth (e.g., Polygonum lapathifolium).
2) From the second to the fifth seasons of growth, the flora reflects that of the surrounding plant communities, and the diversity of species is highest and characterized by the presence of an association of annual, biennial, and perennial "weeds"; Cirsium arvense is dominant.
3) Beyond the tenth season of growth, shrubs and trees dominate (e.g., Cornus drummondii, Populus deltoides, Salix spp.).
4) The bases of the dikes are continually subjected to fluctuating water levels. This natural disturbance provides an optimal habitat for certain wetland species (e.g., Impatiens capensis).
5) Dike maintenance procedures promote the establishment of grasses and Cirsium arvense.
6) Partially because of the moisture gradient on the dike, species in the flora can be compartmentalized as follows: species of man-disturbed habitats occur on the upper,

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APPENDIX A

Estimated Abundances, Frequencies, and Relative Densities of the Taxa on the Dikes

Thirty-five lists of taxa were prepared for the twenty-one dikes which were studied. The lists are presented as individual tables numbered A1 to A35. Each table contains the following information about the flora of the dike: the number of the dike and the name of the marsh in which the dike was located; the date of study; the number of transects utilized to quantify the frequency and the relative density percentages, where applicable; obvious disturbances that may have influenced the succession of plant communities; an assessment of the composition and condition of the substrate; the most obvious sources of seeds (other than the plants of the dike) for the resultant flora; lists of taxa arranged alphabetically within abundance classes; and frequencies and relative densities of the taxa on those dikes on which the flora was quantified. These tables are grouped primarily by the number of consecutive growing seasons, beginning with those dikes in the first season of growth; secondarily, the tables are arranged in numerical order by the numbers of the dikes.

Preceding these tables are two synopses. Synopsis 1 shows the numerical order of the tables within each grouping of the tables by the number of consecutive seasons of growth. Included with the number of each table is the corresponding number of the dike, the marsh in which the dike was located, and the year in which the dike was studied. Synopsis 2 is a cross-reference to Synopsis 1. Synopsis 2 shows the numerical order of the dikes and the corresponding number(s) of the

table(s) which pertain to each dike.

The following abbreviations are utilized in Appendix A. In Synopses 1 and 2, MA = Magee Marsh, MO = Moxley's Marsh, and WI = Winous Point Shooting Club. In Tables A1 to A35, A = abundant, C = common, O = occasional, R = rare, and LC = locally common. Please see the Techniques sub-heading in the METHODS OF STUDY section for an explanation of these abundance classes.

SYNOPSIS 1. The Numerical Order of the Tables in Appendix A.

Number of Table	Number of Dike	Location	Year of Study
First Season of Growth			
A1	2	WI	1976
A2	5	WI	1976
A3	5	WI	1977 (1,4)*
A4	5	WI	1977 (2,4)
A5	13	MA	1976
A6	13	MA	1977
A7	14	MA	1976
A8	16**	MA	1976
A9	18	WI	1977 (1,4)
A10	18	WI	1977 (2,4)
A11	22	MA	1977
Second Season of Growth			
A12	7	MO	1976
A13	10	MO	1976
A14	17	WI	1977
Third Season of Growth			
A15	6	WI	1976
A16	9	MO	1976
A17	10	MO	1977 (1,3)
A18	10	MO	1977 (2,3)
A19	11	MO	1976
Fourth Season of Growth			
A20	3	WI	1976
A21	4	WI	1976
A22	9	MO	1977 (1,3)
A23	9	MO	1977 (2,3)
A24	11	MO	1977 (1,6)
A25	11	MO	1977 (2,6)
A26	19	WI	1977 (1,5)
A27	19	WI	1977 (2,5)
Fifth Season of Growth			
A28	4	WI	1977 (1,5)
A29	4	WI	1977 (2,5)
A30	15	MA	1976
A31	16	MA	1976

SYNOPSIS 1, continued

Number of Table	Number of Dike	Location	Year of Study
Tenth Season of Growth (approximately)			
A32	8	MO	1976
Ten to Twenty-five Seasons of Growth			
A33	20	WI	1977 (1,4)
Twenty-five or More Seasons of Growth			
A34	12	MO	1976
A35	21	MO	1977 (1,1)

*The first number in the parentheses denotes the number of the quantification, 1 for the first quantification, and 2 for the second quantification. The second number is for the number of transects in the quantification.

**The north slope only.

SYNOPSIS 2. The Numerical Listing of the Dikes and the Corresponding Numbers of the Tables.

Number of Dike	Number(s) of Table(s)	Location
2	A1	WI
3	A20	WI
4	A21,A28,A29	WI
5	A2,A3,A4	WI
6	A15	WI
7	A12	MO
8	A32	MO
9	A16,A22,A23	MO
10	A13,A17,A18	MO
11	A19,A24,A25	MO
12	A34	MO
13	A5,A6	MA
14	A7	MA
15	A30	MA
16	A8,A31	MA
17	A14	WI
18	A9,A10	WI
19	A26,A27	WI
20	A33	WI
21	A35	MO
22	A11	MA

TABLE A1. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 2 at Winous Point Shooting Club.

Location: Mink Island dike at east end of MacRitchie Marsh
Date of study: 22 July 1976
Disturbances: recent construction
Substrate: dredged lacustrine deposits and marsh sediments
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Abundant

Polygonum lapathifolium

Common

Carex sp.
Hibiscus palustris

Occasional

Acer negundo
Convolvulus sepium
Cuscuta gronovii
Echinochloa walteri
Populus deltoides
Salix interior
Sambucus canadensis
Solanum dulcamara

Rare

Arctium lappa
Polygonum coccineum

TABLE A2. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 5 at Winous Point Shooting Club.

Location: parallel to private entrance road
Date of study: 2 September 1976
Disturbances: recent construction
Substrate: organic sediments and aged lacustrine clay deposits
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Abundant

Polygonum lapathifolium

Common

Amaranthus retroflexus
Impatiens capensis
Polygonum pensylvanicum

Occasional

Atriplex patula var. hastata
Bidens cernua
B. connata
Convolvulus sepium
Cyperus erythrorhizos
C. ferruginescens
Echinochloa walteri
Eclipta alba
Hibiscus palustris
Polygonum hydropiper
Scutellaria lateriflora

Rare

Asclepias incarnata
Cyperus strigosus
Lycopersicon esculentum
Lycopus europaeus
Medicago lupulina
Mentha piperita
Oenothera biennis
Panicum dichotomiflorum
Phalaris arundinacea
Polygonum punctatum
Populus deltoides
Ranunculus sceleratus
Rorippa palustris var. hispida
Sagittaria latifolia
Salix fragilis
Scirpus fluviatilis
Scutellaria epilobiifolia
Strophostyles helvola
Taraxacum officinale

TABLE A3. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a First Growing Season (First Quantification) as Observed on Dike Number 5 at Winous Point Shooting Club.

Location: parallel to private entrance road
Date of study: 4 transects established on 21 June 1977
Disturbances: constructed last year, not graded
Substrate: organic sediments and aged lacustrine clay deposits
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Polygonum lapathifolium	14.3	22.1
A	Melilotus spp., vegetative	13.9	18.4
A	Cirsium arvense	10.0	15.2
C	Polygonum punctatum	6.7	15.8
O	Phalaris arundinacea	6.0	3.2
C	Impatiens capensis	4.4	8.3
O	Brassica kaber	3.1	3.7
O	Arctium lappa	3.0	2.3
O	Convolvulus sepium	2.1	1.4
O	Polygonum coccineum	2.0	1.4
R	Cornus drummondii	1.4	0.9
O	Hibiscus palustris	1.3	2.8
R	Amaranthus retroflexus	0.8	0.5
R	Plantago rugellii	0.8	0.5
R	Rumex crispus	0.8	0.5
R	Vitis riparia	0.8	0.5
R	Panicum sp.	0.7	1.4
R	Bidens cernua	0.7	1.4
R	B. frondosa	0.7	0.5
R	Polygonum persicaria	0.7	0.5
R	P. pensylvanicum	0.7	0.5
R	Ranunculus abortivus	0.7	0.5
R	Solanum nigrum	0.6	0.5

TABLE A3, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike:	
O	Alliaria officinalis
R	Abutilon theophrasti
R	Acalypha rhomboidea
R	Apocynum cannabinum
R	Asclepias incarnata
R	Bidens connata
R	Carex sp.
R	Circaea quadrisulcata
R	Cuscuta gronovii
R	Echinchloa pungens
R	Eragrostis hypnoides
R	Eupatorium perfoliatum
R	Fraxinus pennsylvanica
R	Hibiscus trionum
R	Lysimachia ciliata
R	Oenothera biennis
R	Oxalis europaea
R	Parthenocissus inserta
R	Phragmites australis
R	Populus deltoides
R	Rhus typhina
R	Ribes americanum
R	Rorippa palustris var. hispida
R	Rubus sp.
R	Sparganium eurycarpum
R	Thlaspi arvense

TABLE A4. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a First Growing Season (Second Quantification) as Observed on Dike Number 5 at Winous Point Shooting Club.

Location: parallel to private entrance road
Date of study: 12 September 1977; 4 transects
Disturbance: graded on top in July
Substrate: organic sediments and aged lacustrine clay deposits
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	46.8	32.7
A	Polygonum lapathifolium	37.0	22.0
C	Melilotus spp., vegetative	19.4	5.4
C	Impatiens capensis	10.4	3.0
O	Convolvulus sepium	8.8	2.0
O	Polygonum pensylvanicum	7.4	2.1
O	P. punctatum	7.0	3.7
O	Arctium lappa	6.5	1.2
O	Phalaris arundinacea	6.0	19.6
O	Hibiscus palustris	5.8	1.4
R	Atriplex patula var. hastata	3.6	1.0
R	Polygonum coccineum	3.0	0.5
R	Bidens cernua	2.8	0.9
R	Echinochloa walteri	2.2	1.0
R	Mentha arvensis	2.0	0.7
R	Vitis riparia	1.6	0.3
R	Acalypha rhomboidea	1.5	0.4
R	Oenothera biennis	1.5	0.3
R	Bidens connata	1.4	0.4
R	Cornus drummondii	1.3	0.4
R	Solanum carolinense	1.3	0.3
R	Phragmites australis	0.8	0.3
R	Plantago rugellii	0.8	0.1
R	Apocynum cannabinum	0.7	0.1
R	Asclepias incarnata	0.7	0.1
R	Scutellaria lateriflora	0.7	0.1

TABLE A4, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike:	
R	Abutilon theophrasti
R	Cuscuta gronovii
R	Eragrostis hypnoides
R	Fraxinus pennsylvanica
R	Hibiscus trionum
R	Parthenocissus inserta
R	Populus deltoides
R	Rhus typhina
R	Rorippa palustris var. hispida

TABLE A5. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 13 at Magee Marsh

Location: L-shaped dike, east of entrance road
Date of study: 9 September 1976
Disturbances: road on top; this dike has been maintained constantly for the previous sixteen years; also, the slopes have been submerged during the hunting seasons
Substrate: firm clay
Seed sources: plants of adjacent marshes

Abundant

Amaranthus tuberculatus
Cyperus ferruginescens
Polygonum lapathifolium
Populus deltoides

Common

Abutilon theophrasti
Cirsium arvense
Polygonum pensylvanicum
Strophostyles helvola

Occasional

Amaranthus graecizans
Arctium lappa
Ascelpias incarnata
Atriplex patula var. hastata
Bidens cernua
Brassica kaber
Chenopodium album
Convolvulus sepium
Cuscuta gronovii
Cyperus erythrorhizos
Echinochloa pungens
Eragrostis hypnoides
Hibiscus palustris
Melilotus alba
Oenothera biennis
Parthenocissus inserta
Poa pratensis
Scutellaria epilobiifolia
Setaria faberii
S. viridis
Solanum nigrum
Verbena hastata
Vitis riparia

Rare

Ambrosia artemisiifolia
Aster simplex
Carex sp.
Cirsium vulgare
Cornus drummondii
Echinochloa walteri
Eragrostis pectinacea
Euphorbia maculata
Hibiscus trionum
Hordeum jubatum
Ipomoea purpurea
Lycopus americanus
L. europaeus
Medicago lupulina
Panicum capillare
P. dichotomiflorum
Polygonum coccineum
Rumex crispus
Salix rigida
Solidago nemoralis

TABLE A6. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 13 at Magee Marsh.

Location: L-shaped dike, east of the main road through the marsh
Date of study: 7 October 1977
Disturbances: construction completed in September
Substrate: dredged marsh sediments
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Abundant

Cirsium arvense

Common

Abutilon theophrasti
Brassica kaber
Convolvulus sepium
Polygonum coccineum
Sonchus sp., rosettes

Occasional

Asclepias incarnata
Calamagrostis canadensis
Dipsacus sylvestris
Echinochloa pungens
E. walteri
Hibiscus trionum
Oenothera biennis
Phytolacca americana

Rare

Arctium lappa
Bidens cernua
Cirsium vulgare
Phalaris arundinacea
Polygonum lapathifolium
P. pensylvanicum
P. punctatum
Rhus typhina
Rumex crispus
Solanum dulcamara
Verbena hastata

TABLE A7. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 14 at Magee Marsh.

Location: new stone outer dike bordering Lake Erie
Date of study: 9 September 1976
Disturbances: recent construction; road on top
Substrate: soil base covered with limestone rock
Seed sources: plants of adjacent marshes and shoreline

Abundant

Cyperus ferruginescens
Panicum capillare

Common

Arctium lappa
Atriplex patula var. hastata
Bidens cernua
Cirsium arvense
Convolvulus sepium
Leersia oryzoides
Polygonum lapathifolium

Occasional

Abutilon theophrasti
Amaranthus graecizans
Ambrosia artemisiifolia
Asclepias incarnata
Brassica kaber
Cyperus erythrorhizos
Echinochloa walteri
Impatiens capensis
Oenothera biennis
Panicum lanuginosum
Polygonum aviculare
Vitis riparia

Rare

Asclepias syriaca
Atriplex patula var. patula
Bidens frondosa
Cyperus strigosus
Daucus carota
Digitaria sanguinalis
Euphorbia serpyllifolia
Hibiscus palustris
Lepidium virginicum
Lotus corniculatus
Medicago lupulina
Oxalis europaea
Panicum dichotomiflorum
Polanisia dodecandra
Polygonum coccineum
P. hydropiper
P. pensylvanicum
P. scandens
Rhus typhina
Scirpus validus
S. fluviatilis
Setaria viridis
Sonchus asper
Strophostyles helvola
Teucrium canadense
Trifolium repens
Typha angustifolia
Verbena hastata

TABLE A8. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 16 (North Slope Only) at Magee Marsh.

Location: 100 feet south of and parallel to the east/west portion of dike number 13
Date of study: 13 September 1976
Disturbances: periodic inundation
Substrate: firm clay
Seed sources: plants of adjacent marshes (water as a primary dispersal agent)

Abundant

Abutilon theophrasti
Cornus drummondii
Polygonum lapathifolium

Common

Asclepias incarnata
Brassica kaber
Cyperus erythrorhizos
Panicum capillare
Polygonum pensylvanicum

Occasional

Bidens cernua
Cyperus ferruginescens
Echinochloa pungens
Impatiens capensis
Ludwigia palustris var. americana
Lycopus americanus
Oenothera biennis
Oxalis europaea
Populus deltoides
Ranunculus sceleratus
Rumex crispus
Scutellaria epilobiifolia

Rare

Erechtites hieracifolia
Geum sp.
Solanum nigrum

TABLE A9. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a First Growing Season (First Quantification) as Observed on Dike Number 18 at Winous Point Shooting Club.

Location: new outer dike bordering Sandusky Bay
Date of study: 4 transects established on 21 June 1977
Disturbances: recent construction of dike; celotex roadway on top; side facing bay composed of massive pieces of limestone
Substrate: recently dredged organic sediments and aged lacustrine clay deposits
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Polygonum lapathifolium	46.9	92.8
R	Thlaspi arvense	0.6	3.2
R	Abutilon theophrasti	0.6	1.6
R	Daucus carota	0.6	0.8
R	Hibiscus trionum	0.6	0.8
R	Melilotus officinalis	0.6	0.8
Additional taxa observed on dike:			
O	Atriplex patula var. hastata		
O	Chenopodium album		
O	Cyperus erythrorhizos		
O	C. ferruginescens		
O	Hibiscus palustris		
R	Brassica kaber		
R	Chaenorrhinum minus		
R	Poa pratensis		
R	Polygonum pensylvanicum		
R	Solanum dulcamara		
R	Taraxacum officinale		
R	Typha sp.		

TABLE A10. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a First Growing Season (Second Quantification) as Observed on Dike Number 18 at Winous Point Shooting Club.

Location: new outer dike bordering Sandusky Bay
Date of study: 13 September 1977; 4 transects
Disturbances: recent construction of dike; celotex roadway on top; side facing bay composed of massive pieces of limestone
Substrate: recently dredged organic sediments and aged lacustrine clay deposits
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Polygonum lapathifolium	41.2	73.9
O	Medicago lupulina	2.1	2.5
O	Hibiscus trionum	1.7	1.5
LC	Phalaris arundinacea	1.5	8.9
O	Leersia oryzoides	1.3	5.4
O	Hibiscus palustris	1.2	1.5
R	Asclepias incarnata	1.1	1.0
O	Polygonum pensylvanicum	1.1	1.5
O	Abutilon theophrasti	0.6	1.0
O	Ambrosia artemisiifolia	0.6	0.5
R	Cyperus ferruginescens	0.6	0.5
O	Melilotus officinalis	0.6	0.5
O	Atriplex patula var. hastata	0.5	0.5
R	Echinochloa walteri	0.5	0.5
R	Panicum dichotomiflorum	0.5	0.5
Additional taxa observed on dike:			
R	Arctium lappa		
R	Aster sp.		
R	Bidens frondosa		
R	Brassica kaber		
R	Chaenorrhinum minus		
R	Chenopodium album		
R	Cichorium intybus		
R	Cirsium arvense		

TABLE A10, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
R	Convolvulus sepium
R	Daucus carota
R	Oenothera biennis
R	Pastinaca sativa
R	Phytolacca americana
R	Poa pratensis
R	Populus deltoides
R	Salix amygdaloides
R	Setaria viridis
R	Solanum dulcamara
R	Taraxacum officinale
R	Typha angustifolia
R	Xanthium strumarium

TABLE A11. Estimated Abundances of Taxa Present in a First Growing Season as Observed on Dike Number 22 at Magee Marsh.

Location: new dike constructed last year along the southern border of Crane Creek State Park
Date of study: 1 October 1977
Disturbances: recent construction and some vehicular travel over the top
Substrate: firm; dredged marsh sediments, as well as hauled fill
Seed sources: deposits in marsh sediments; plants of adjacent marshes and lakeshore

Abundant

Polygonum aviculare

Common

Acalypha rhomboidea
Euphorbia maculata
E. supina
Hibiscus trionum
Polygonum coccineum
P. pensylvanicum

Occasional

Abutilon theophrasti
Acer negundo
Atriplex patula
Bidens cernua
Convolvulus sepium
Cyperus erythrorhizos
Cyperus ferruginescens
Impatiens capensis
Polygonum lapathifolium
Rhus typhina
Verbena hastata

Rare

Amaranthus albus
Apocynum cannabinum
Arctium lappa
Asclepias incarnata
Chaenorrhinum minus
Cirsium arvense
C. vulgare
Cornus obliqua
Echinochloa pungens
E. walteri
Hibiscus palustris
Lycopus americanus
L. europaeus
Medicago lupulina
Melilotus officinalis
Oenothera biennis
Penthorum sedoides
Plantago rugellii
Sparganium eurycarpum

TABLE A12. Estimated Abundances of Taxa Present in a Second Growing Season as Observed on Dike Number 7 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; this dike is the continuation of dike number 10; this section borders route 2 (freeway)
Date of study: 7 September 1976
Disturbances: recent construction; road on top
Substrate: very friable; high organic matter content
Seed sources: deposits in marsh sediments; plants of adjacent marshes

Abundant

Abutilon theophrasti
Cirsium arvense
Polygonum lapathifolium

Common

Convolvulus sepium
Impatiens capensis

Occasional

Asclepias incarnata
Cirsium vulgare
Cyperus strigosus
Echinochloa pungens
E. walteri
Leersia oryzoides
Lycopus americanus
Oenothera biennis
Panicum capillare
Polygonum pensylvanicum
Solanum nigrum
Strophostyles helvola
Typha angustifolia
Verbena hastata

Rare

Amaranthus retroflexus
Lythrum salicaria
Populus deltoides
Solanum dulcamara

TABLE A13. Estimated Abundances of Taxa Present in a Second Growing Season as Observed on Dike Number 10 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; this dike is parallel to number 9, but is in the "Woods" marsh
Date of study: 8 September 1976
Disturbances: road on top; topped and graded one year ago
Substrate: friable soil with a high organic matter content
Seed sources: deposits in marsh sediments; plants of adjacent marshes and roads

Abundant

Cirsium arvense
Polygonum lapathifolium

Common

Convolvulus sepium
Leersia oryzoides
Panicum capillare

Occasional

Abutilon theophrasti
Amaranthus retroflexus
A. tuberculatus
Asclepias incarnata
Cyperus ferruginescens
Hibiscus palustris
Impatiens capensis
Lythrum salicaria
Phalaris arundinacea
Phytolacca americana
Polygonum coccineum
Verbena hastata

Rare

Brassica kaber
Chenopodium album
Cuscuta gronovii
Cyperus esculentus
Echinochloa crus-galli
E. walteri
Lycopus americanus
Phragmites australis
Populus deltoides
Rhus typhina
Salix amygdaloides
Sambucus canadensis

TABLE A14. Estimated Abundances of Taxa Present in a Second Growing Season as Observed on Dike Number 17 at Winous Point Shooting Club.

Location: parallel to entrance road from pump to Latimore Road
Date of study: 22 June 1977
Disturbances: topped and graded in 1976
Substrate: organic sediments and aged lacustrine clay deposits
Seed sources: plants of adjacent marshes

Common

Cirsium arvense
Convolvulus sepium
Daucus carota
Lactuca scariola
Phalaris arundinacea
Polygonum coccineum
Salix interior
Sonchus uliginosus

Occasional to rare

Abutilon theophrasti
Ambrosia trifida
Apocynum cannabinum
Arctium lappa
Asclepias incarnata
A. syriaca
Aster simplex
Barbarea vulgaris
Bidens frondosa
Brassica kaber
Bromus sp.
Chenopodium album
Cornus drummondii
Dactylis glomerata
Dipsacus sylvestris
Eragrostis hypnoides
Erigeron annuus
Galium tinctorium
Hibiscus palustris
Hordeum jubatum
Impatiens capensis
Lepidium campestre
Lycopus americanus
Lysimachia nummularia
Melilotus alba
Mentha arvensis
Mirabilis nyctaginea
Oenothera biennis
Oxalis europaea
Parthenocissus inserta
Plantago rugellii
Poa pratensis
Polygonum aviculare
Populus deltoides
Rhus typhina
Rumex crispus
Sambucus canadensis
Solidago sp.
Sparganium eurycarpum
Stachys tenuifolia
Taraxacum officinale
Tragopogon pratensis
Vitis riparia

TABLE A15. Estimated Abundances of Taxa Present in a Third Growing Season as Observed on Dike Number 6 at Winous Point Shooting Club.

Location: parallel to private entrance road
Date of study: 2 September 1976
Disturbances: parts of this dike are shaded; has not been mowed for two years
Substrate: lacustrine clay
Seed sources: plants of adjacent marsh and swamp

Abundant

Phalaris arundinacea

Common

Cornus drummondii
Parthenocissus inserta

Occasional

Acer negundo
Alliaria officinalis
Amaranthus retroflexus
Asclepias incarnata
Carex sp.
Cirsium arvense
Convolvulus sepium
Fraxinus pennsylvanica
Geum canadense
Hibiscus palustris
Impatiens capensis
Lycopus americanus
Lysimachia nummularia
Melilotus alba
Oenothera biennis
Phragmites australis
Polygonum coccineum
Quercus palustris
Rhus typhina
Scutellaria epilobiifolia
S. lateriflora
Verbena hastata
Vitis riparia

Rare

Arctium lappa
Brassica kaber
Celtis occidentalis
Cuscuta gronovii
Echinochloa walteri
Lycopus europaeus
Mentha piperita
Oxalis europaea
Pilea pumila
Populus deltoides
Rhus glabra
R. radicans
Rorippa sylvestris
Rumex crispus
Sambucus canadensis
Teucrium canadense
Triosteum perfoliatum
Typha latifolia

TABLE A16. Estimated Abundances of Taxa Present in a Third Growing Season as Observed on Dike Number 9 at Moxley's Marsh

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; the pump for the "B" marsh is on this dike
Date of study: 8 September 1976
Disturbances: road on top, periodic mowing
Substrate: friable, dredged marsh sediments
Seed sources: Festuca elatior has been seeded by the manager of the marsh; plants of adjacent marshes and fields

Abundant

Cirsium arvense
Festuca elatior
Impatiens capensis

Common

Asclepias incarnata
Convolvulus sepium
Hibiscus palustris
Sonchus asper

Occasional

Abutilon theophrasti
Apocynum cannabinum
Cornus drummondii
Cuscuta gronovii
Echinochloa walteri
Lactuca scariola
Oenothera biennis
Panicum capillare
Scutellaria epilobiifolia
Solanum dulcamara
S. nigrum
Verbena hastata
Vitis riparia

Rare

Amaranthus tuberculatus
Ambrosia trifida
Arctium lappa
Brassica kaber
Calamagrostis canadensis
Carduus nutans
Chenopodium album
Cichorium intybus
Dipsacus sylvestris
Echinochloa pungens
Lycopus americanus
Lythrum salicaria
Medicago lupulina
Phalaris arundinacea
Phragmites australis
Polygonum aviculare
P. coccineum
P. lapathifolium
P. pensylvanicum
Populus deltoides
Potentilla anserina
Rhus typhina
Rumex crispus
Salix fragilis
Sambucus canadensis
Setaria viridis
Typha angustifolia

TABLE A17. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Third Growing Season (First Quantification) as Observed on Dike Number 10 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; this dike is parallel to number 9, but is in the "Woods" marsh
Date of study: 3 transects were established on 30 June 1977
Disturbances: road on top; topped and graded two years ago
Substrate: friable soil with a high organic matter content
Seed sources: Polygonum lapathifolium became established from the marsh sediments which were used to top the dike; Lolium multiflorum was seeded by the marsh manager; plants of adjacent marshes and roads

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from the transects:			
A	Cirsium arvense	34.6	14.0
A	Lolium multiflorum	25.8	45.4
A	Impatiens capensis	22.1	17.7
C	Polygonum lapathifolium	18.9	7.2
C	Phalaris arundinacea	15.2	9.7
O	Verbena hastata	11.3	1.2
O	Festuca elatior	2.5	2.8
O	Convolvulus sepium	2.5	1.1
O	Hibiscus palustris	2.5	0.2
R	Brassica kaber	1.3	0.2
R	Acer saccharinum	1.3	0.1
R	Phytolacca americana	1.3	0.1
R	Asclepias incarnata	1.2	0.1
Additional taxa observed on dike:			
R	Abutilon theophrasti		
R	Phragmites australis		
R	Rhus typhina		
R	Rumex maritimus		
R	Salix sp.		
R	Scutellaria epilobiifolia		

TABLE A18. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Third Growing Season (Second Quantification) as Observed on Dike Number 10 at Moxley's Marsh

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; this dike is parallel to number 9, but is in "Woods" marsh
Date of study: 9 September 1977; 3 transects
Disturbances: road on top; mowed in August
Substrate: friable soil with a high organic matter content
Seed sources: Polygonum lapathifolium became established from the marsh sediments which were used to top the dike; Festuca elatior and Lolium multiflorum were seeded by the marsh manager; plants of adjacent marshes and roads

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	44.2	24.9
A	Festuca elatior and Lolium multiflorum	33.2	10.1
A	Impatiens capensis	24.1	19.9
A	Polygonum lapathifolium	23.0	14.8
C	Phalaris arundinacea	12.6	16.0
C	Verbena hastata	11.6	1.8
C	Asclepias incarnata	11.4	1.7
C	Convolvulus sepium	11.1	2.3
LC	Leersia oryzoides	10.0	6.5
O	Phytolacca americana	3.9	0.5
O	Hibiscus palustris	3.7	0.4
R	Lythrum salicaria	2.5	0.2
O	Abutilon theophrasti	1.4	0.1
R	Panicum capillare	1.3	0.6
R	Acer saccharinum	1.3	0.1
R	Chenopodium album	1.3	0.1
R	Rhus typhina	1.3	0.1
Additional taxa observed on dike:			
O	Brassica kaber		

TABLE A18, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
O	Echinochloa walteri
O	Oenothera biennis
R	Solanum nigrum

TABLE A19. Estimated Abundances of Taxa Present in a Third Growing Season as Observed on Dike Number 11 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from route 269, ¼ mile north of route 2; this dike is the continuation of dike number 9
Date of study: 8 September 1976
Disturbances: road on top, periodic mowing
Substrate: friable soil with a high organic matter content
Seed sources: Festuca elatior was seeded by the manager of the marsh; plants of adjacent marshes and roads

Abundant

Cirsium arvense
Festuca elatior

Common

Asclepias incarnata
Brassica kaber
Convolvulus sepium
Hibiscus palustris
Oenothera biennis

Occasional

Echinochloa walteri
Solanum dulcamara
Sonchus asper

Rare

Arctium lappa
Daucus carota
Dipsacus sylvestris
Echinochloa pungens
Epilobium hirsutum
Impatiens capensis
Melilotus alba
Polygonum pensylvanicum
Populus deltoides
Rhus typhina
Salix amygdaloides
S. interior
Setaria viridis
Sicyos angulatus
Strophostyles helvola
Verbena hastata
Vitis riparia

TABLE A20. Estimated Abundances of Taxa Present in a Fourth Growing Season as Observed on Dike Number 3 at Winous Point Shooting Club.

Location: at northeastern end of Winous Point Shooting Club near Wilcox and Wonnell Roads
Date of study: 2 September 1976
Disturbances: topped in 1966, disced and mowed in 1972; in 1977, this dike was demolished
Substrate: lacustrine clay deposits
Seed sources: plants of adjacent marshes and fields; Phalaris arundinacea was seeded by marsh manager

Abundant

Phalaris arundinacea

Common

Asclepias incarnata
Cirsium arvense
Convolvulus sepium
Cornus drummondii
Parthenocissus inserta

Occasional

Brassica kaber
Hibiscus palustris
Impatiens capensis
Lycopus americanus
Melilotus alba
M. officinalis
Oenothera biennis
Polygonum scandens
Rhus glabra
R. typhina
Ribes americanum
Rumex crispus
Scirpus sp.
Vitis riparia

Rare

Apocynum cannabinum
Aster simplex
Dipsacus sylvestris
Epilobium glandulosum
Fraxinus pennsylvanica
Leersia oryzoides
Parthenocissus inserta
Polygonum pensylvanicum
P. punctatum
Sambucus canadensis
Solanum carolinense
S. dulcamara
Strophostyles helvola
Thlaspi arvense
Verbena hastata

TABLE A21. Estimated Abundances of Taxa Present in a Fourth Growing Season as Observed on Dike Number 4 at Winous Point Shooting Club.

Location: along the north border, east of the entrance road, enter near the carp pond
Date of study: 2 September 1976
Disturbances: top was mowed one year ago
Substrate: firm clay with some damage from animals
Seed sources: Calamagrostis canadensis and Phalaris arundinacea were seeded by the marsh manager; plants of adjacent marshes and agricultural land

Abundant

Cirsium arvense
Melilotus alba
M. officinalis
Phalaris arundinacea

Common

Abutilon theophrasti
Asclepias incarnata
Convolvulus sepium
Cornus drummondii
Polygonum coccineum

Occasional

Arctium lappa
Brassica kaber
Chenopodium album
Hibiscus palustris
Lycopus americanus
Oxalis europaea
Parthenocissus inserta
Polygonum pensylvanicum
P. punctatum
Sambucus canadensis
Scutellaria epilobiifolia
Vitis riparia

Rare

Apocynum cannabinum
Bidens frondosa
Calamagrostis canadensis
Cirsium vulgare
Dipsacus sylvestris
Echinochloa pungens
Elymus virginicus
Gaura biennis
Gleditsia triacanthos
Impatiens capensis
Medicago lupulina
Mentha piperita
Oenothera biennis
Panicum capillare
Phytolacca americana
Populus deltoides
Rumex crispus
Scirpus fluviatilis
Solidago nemoralis
Stachys palustris
Strophostyles helvola
Verbena hastata

TABLE A22. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (First Quantification) as Observed on Dike Number 9 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; the pump for the "B" marsh is on this dike
Date of study: 3 transects established on 30 June 1977
Disturbances: road on top, periodic mowing
Substrate: friable, dredged marsh sediments
Seed sources: Festuca elatior was seeded by the manager of the marsh; plants of adjacent marshes and fields

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Festuca elatior	57.6	63.2
A	Cirsium arvense	42.5	8.2
A	Impatiens capensis	37.7	24.7
C	Convolvulus sepium	12.7	0.6
C	Verbena hastata	10.2	1.0
O	Sonchus asper	4.9	0.3
O	Lycopus americanus	2.7	0.5
R	Oenothera biennis	2.7	0.1
R	Taraxacum officinale	2.7	0.1
R	Asclepias incarnata	2.6	0.2
O	Lythrum salicaria	2.5	0.1
O	Phalaris arundinacea	1.3	0.7
O	Scutellaria epilobiifolia	1.3	0.3
O	Hibiscus palustris	1.3	0.1
R	Solanum dulcamara	1.3	0.1
Additional taxa observed on dike:			
R	Ambrosia trifida		
R	Apocynum cannabinum		
R	Arctium lappa		
R	Carduus nutans		
R	Cichorium intybus		
R	Cornus sp.		
R	Lactuca sp.		

TABLE A22, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
R	Melilotus alba
R	Nepeta cataria
R	Phragmites australis
R	Rumex crispus
R	Salix sp.
R	Teucrium canadense
R	Vitis riparia

TABLE A23. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (Second Quantification) as Observed on Dike Number 9 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; the pump for the "B" marsh is on this dike
Date of study: 9 September 1977; 3 transects
Disturbances: road on top; has been mowed once since July
Substrate: friable, dredged marsh sediments
Seed sources: Festuca elatior was seeded by the manager of the marsh; plants of adjacent marshes and fields

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	46.2	20.5
A	Festuca elatior	43.3	18.8
A	Impatiens capensis	29.7	41.0
A	Convolvulus sepium	12.0	5.5
O	Asclepias incarnata	9.3	0.9
C	Verbena hastata	8.1	1.4
O	Lycopus americanus	6.9	1.7
O	Oenothera biennis	4.1	0.7
O	Cuscuta gronovii	2.8	0.8
O	Panicum capillare	2.7	7.7
O	Hibiscus palustris	2.7	0.6
R	Scutellaria epilobiifolia	1.4	0.2
R	Nepeta cataria	1.3	0.1
Additional taxa observed on dike:			
O	Echinochloa walteri		
O	Lythrum salicaria		
O	Setaria viridis		
O	Solanum dulcamara		
O	Sonchus asper		
R	Abutilon theophrasti		
R	Apocynum cannabinum		
R	Arctium lappa		
R	Cornus amomum or C. obliqua		
R	Leersia oryzoides		

TABLE A23, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
R	Phalaris arundinacea
R	Phragmites australis
R	Polygonum coccineum
R	P. lapathifolium
R	Teucrium canadense

TABLE A24. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (First Quantification) as Observed on Dike Number 11 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from route 269, ¼ mile north of route 2; this dike is the continuation of number 9
Date of study: 6 transects were established on 6 July 1977
Disturbances: road on top, periodic mowing
Substrate: friable, high organic matter content, some animal damage
Seed sources: Festuca elatior was seeded by the manager of the marsh; plants of adjacent marshes and roads

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense*	38.9	22.0
A	Festuca elatior	33.9	20.4
A	Brassica kaber*	29.4	16.6
A	Convolvulus sepium	23.8	11.2
A	Impatiens capensis	22.7	20.0
C	Asclepias incarnata*	9.7	4.7
C	Solanum dulcamara*	8.4	3.2
O	Oenothera biennis	4.3	1.1
R	Hibiscus palustris	2.3	0.3
R	Scutellaria epilobiifolia	2.1	0.4
R	Sambucus canadensis	0.9	0.1
R	Sonchus uliginosus	0.5	0.1
Additional taxa observed on dike:			
O	Salix interior		
O	Verbena hastata		
R	Apocynum cannabinum		
R	Arctium lappa		
R	Carduus nutans		
R	Cuscuta gronovii		
R	Nepeta cataria		
R	Phragmites australis		
R	Populus deltoides		
R	Rhus typhina		

TABLE A24, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
R	Salix fragilis

*Existed in discrete zones along the dike.

TABLE A25. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (Second Quantification) as Observed on Dike Number 11 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from route 269, ¼ mile north of route 2; this dike is the continuation of number 9
Date of study: 10 September 1977; 6 transects
Disturbances: road on top, periodic mowing
Substrate: friable, high organic matter content, some animal damage
Seed sources: Festuca elatior was seeded by the manager of the marsh; plants of adjacent marshes and roads

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	39.1	30.6
A	Impatiens capensis	26.6	33.5
A	Convolvulus sepium	21.6	19.0
C	Asclepias incarnata	18.1	7.5
C	Solanum dulcamara	9.0	4.9
C	Festuca elatior	8.3	1.1
O	Oenothera biennis	4.0	2.0
O	Hibiscus palustris	3.4	0.8
R	Vitis riparia	1.3	0.3
R	Sambucus canadensis	0.9	0.2
R	Brassica kaber	0.7	0.1
Additional taxa observed on dike:			
O	Apocynum cannabinum		
O	Cuscuta gronovii		
O	Salix interior		
O	Verbena hastata		
R	Carduus nutans		
R	Echinochloa walteri		
R	Panicum capillare		
R	Phytolacca americana		
R	Populus deltoides		
R	Salix fragilis		
R	Scutellaria epilobiifolia		

TABLE A25, continued

Estimated Abundance	Name of Plant
Additional taxa observed on dike, continued:	
R	Solanum nigrum
R	Verbascum thapsus

TABLE A26. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (First Quantification) as Observed on Dike Number 19 at Winous Point Shooting Club.

Location: west of and adjacent to entrance road from Latimore Road to culvert
Date of study: 5 transects established on 22 June 1977
Disturbances: periodic mowing
Substrate: firm clay
Seed sources: plants of adjacent fields

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense*	60.1	38.1
O	Taraxacum officinale**	19.0	9.9
R	Salix interior***	18.6	6.2
O	Cornus drummondii	18.6	2.9
C	Daucus carota	15.4	6.3
C	Sonchus uliginosis	14.0	5.3
O	Lactuca scariola	13.3	4.1
O	Bidens frondosa	9.4	2.8
O	Parthenocissus inserta	9.3	2.3
O	Aster sp.	8.6	5.1
O	Oenothera biennis	8.0	2.1
O	Convolvulus sepium	7.5	1.2
O	Phalaris arundinacea	7.3	2.7
O	Ambrosia trifida var. integrifolia	6.5	4.0
O	Stachys tenuifolia	4.8	1.3
O	Lycopus americanus	4.3	1.7
R	Hibiscus palustris	3.0	0.4
R	Vitis riparia	3.0	0.5
R	Erigeron strigosus	2.9	0.7
R	Cirsium vulgare	2.0	0.2
R	Sambucus canadensis	2.0	0.2
R	Solidago sp.	1.4	0.4
R	Brassica kaber	1.4	0.2
R	Asclepias incarnata	1.0	0.1
R	Barbarea vulgaris	1.0	0.1

TABLE A26, continued

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects, continued:			
R	Gleditsia triacanthos	1.0	0.1
R	Rumex crispus	1.0	0.1
R	Plantago rugellii	0.7	0.5
R	Agrimonia sp.	0.7	0.2
R	Arctium lappa	0.7	0.1
R	Oxalis europaea	0.7	0.1
R	Rhus radicans	0.7	0.1
Additional taxa observed on dike:			
R	Alliaria officinalis		
R	Cichorium intybus		
R	Hordeum jubatum		
R	Medicago lupulina		
R	Melilotus alba		
R	Physalis virginiana		
R	Poa pratensis		
R	Polygonum coccineum		
R	Setaria viridis		
R	Thlaspi arvense		
R	Trifolium pratense		
R	T. repens		

*Dominant.
**Common in the first transect.
***Represents a clone which was locally abundant in the second transect.

TABLE A27. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fourth Growing Season (Second Quantification) as Observed on Dike Number 19 at Winous Point Shooting Club.

Location: west of and adjacent to entrance road from Latimore Road to culvert
Date of study: 12 September 1977; 5 transects
Disturbances: none since 22 June 1977
Substrate: firm clay
Seed sources: plants of adjacent fields

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	60.8	18.9
A	Daucus carota	27.3	16.3
O	Cornus drummondii	21.9	2.7
O	Parthenocissus inserta	20.0	1.8
O	Bidens frondosa	18.9	2.8
O	Taraxacum officinale	17.6	4.5
R	Salix interior*	17.0	7.9
C	Sonchus uliginosus	16.2	3.2
O	Aster simplex	14.4	3.7
O	Acalypha rhomboidea	10.0	1.4
O	Erigeron strigosus	8.2	3.2
O	Lycopus americanus	8.2	2.0
O	Oenothera biennis	8.1	1.7
O	Ambrosia trifida var. integrifolia	7.9	1.4
O	Solidago sp.	7.3	1.4
O	Hibiscus palustris	7.3	0.9
O	Phalaris arundinacea	6.7	13.7
O	Medicago lupulina	6.5	3.6
O	Abutilon theophrasti	6.0	1.8
O	Stachys tenuifolia	5.8	1.5
R	Asclepias incarnata	5.8	0.7
R	Strophostyles helvola	5.5	0.4
R	Vitis riparia	5.0	0.4
R	Physalis virginiana	4.8	0.9
R	Melilotus spp.	4.0	0.5

TABLE A27, continued

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects, continued:			
R	Convolvulus sepium	3.6	0.3
R	Sambucus canadensis	2.7	0.3
R	Impatiens capensis	2.6	0.3
R	Setaria viridis	2.3	0.4
R	Cirsium vulgare	1.7	0.1
R	Dipsacus sylvestris	1.4	0.2
R	Agrimonia sp.	1.4	0.1
R	Plantago rugellii	1.4	0.1
R	Gleditsia triacanthos	1.0	0.1
R	Bidens connata	0.8	0.1
R	Scutellaria lateriflora	0.8	0.1
R	Arctium lappa	0.7	0.1
Additional taxa observed on dike:			
R	Ambrosia artemisiifolia		
R	Aster nova-angliae		
R	Cichorium intybus		
R	Digitaria sanguinalis		
R	Euphorbia maculata		
R	Oxalis europaea		
R	Populus deltoides		
R	Trifolium pratense		
R	T. repens		

*Represents a clone which was locally abundant in the second transect.

TABLE A28. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fifth Growing Season (First Quantification) as Observed on Dike Number 4 at Winous Point Shooting Club.

Location: along the north border, east of the entrance road; enter near the carp pond
Date of study: 5 transects established on 15 July 1977
Disturbances: top was mowed two years ago
Substrate: firm clay with some damage from animals
Seed sources: Calamagrostis canadensis and Phalaris arundinacea were seeded by the marsh manager; plants of adjacent marshes and agricultural land

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	76.5	20.5
C	Convolvulus sepium	27.9	4.2
A	Phalaris arundinacea	24.3	20.6
A	Brassica kaber	22.0	28.8
A	Melilotus spp., vegetative	20.3	10.2
C	Cornus drummondii	13.2	1.8
O	Chenopodium album	9.7	2.6
O	Impatiens capensis	9.2	1.8
O	Solanum dulcamara	8.6	0.8
O	Oxalis europaea	8.5	1.5
O	Parthenocissus inserta	7.4	1.1
O	Apocynum cannabinum	6.3	0.5
R	Asclepias incarnata	5.5	0.4
R	Geum canadense	5.4	0.3
R	Vitis riparia	5.0	0.3
R	Polygonum coccineum	4.9	0.3
R	Arctium lappa	4.6	0.3
R	Sonchus uliginosus	3.5	0.2
R	Oenothera biennis	3.3	0.3
R	Hibiscus palustris	3.3	0.2
R	Gleditsia triacanthos	3.0	0.2
R	Polygonum persicaria	2.8	0.4
R	Mentha piperita	2.4	0.4
R	Bidens frondosa	2.4	0.3

TABLE A28, continued

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects, continued:			
R	Rumex crispus	2.4	0.2
R	Daucus carota	2.2	0.1
R	Gaura biennis	1.9	0.1
R	Dipsacus sylvestris	1.8	0.1
R	Physalis alkekengi	1.6	0.1
R	Lycopus americanus	1.5	0.5
R	Polygonum lapathifolium	1.0	0.1
R	Scutellaria epilobiifolia	1.0	0.1
R	Galium sp.	0.8	0.1
R	Agrimonia sp.	0.8	0.1
R	Abutilon theophrasti	0.7	0.1
R	Carex sp.	0.7	0.1
R	Sambucus canadensis	0.7	0.1
Additional taxa observed on dike:			
R	Bidens connata		
R	Phragmites australis		
R	Rosa sp.		

TABLE A29. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present in a Fifth Growing Season (Second Quantification) as Observed on Dike Number 4 at Winous Point Shooting Club.

Location: along the north border, east of the entrance road; enter near the carp pond
Date of study: 14 September 1977; 5 transects
Disturbances: top was mowed two years ago
Substrate: firm clay with some damage from animals
Seed sources: Calamagrostis canadensis and Phalaris arundinacea were seeded by the marsh manager; plants of adjacent marshes and agricultural land

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cirsium arvense	68.8	17.8
A	Phalaris arundinacea	24.8	45.7
C	Melilotus spp., vegetative	19.2	9.0
C	Convolvulus sepium	18.8	0.6
C	Cornus drummondii	16.0	2.1
C	Chenopodium album	15.6	6.3
C	Impatiens capensis	13.1	4.6
O	Polygonum pensylvanicum	11.5	1.0
C	Solanum dulcamara	11.1	0.6
O	Brassica kaber	10.6	1.1
O	Polygonum coccineum	8.9	1.2
O	Oxalis europaea	8.0	1.5
O	Apocynum cannabinum	6.3	1.1
R	Vitis riparia	5.7	0.5
R	Acalypha rhomboidea	4.7	0.5
R	Lycopus americanus	4.6	1.2
R	Hibiscus palustris	4.0	0.2
R	Parthenocissus inserta	3.7	0.5
R	Geum canadense	3.3	0.2
R	Mentha arvensis	3.2	1.2
R	Daucus carota	3.0	0.2
R	Calamagrostis canadensis	2.4	1.4
R	Arctium lappa	2.4	0.1
R	Aster sp.	2.4	0.1
R	Gleditsia triacanthos	2.2	0.1

TABLE A29, continued

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects, continued:			
R	Gaura biennis	1.7	0.1
R	Dipsacus sylvestris	1.5	0.2
R	Asclepias incarnata	1.0	0.1
R	Echinochloa pungens	1.0	0.1
R	Bidens frondosa	0.8	0.1
R	Oenothera biennis	0.8	0.1
R	Physalis alkekengi	0.8	0.1
R	Sonchus uliginosus	0.7	0.1
R	Abutilon theophrasti	0.7	0.1
R	Lycopus europaeus	0.7	0.1
R	Melilotus officinalis	0.7	0.1
R	Solidago sp.	0.7	0.1
Additional taxa observed on dike:			
R	Alisma plantago-aquatica		
R	Cyperus erythrorhizos		
R	C. ferruginescens		
R	Echinochloa walteri		
R	Leersia oryzoides		
R	Phragmites australis		
R	Sambucus canadensis		
R	Sparganium eurycarpum		

TABLE A30. Estimated Abundances of Taxa Present in a Fifth Growing Season as Observed on Dike Number 15 at Magee Marsh.

Location: west of the entrance road and behind the interpretive center
Date of study: 10 September 1976
Disturbances: has not been mowed for three years; north slope periodically inundated
Substrate: firm clay
Seed sources: plants of adjacent marshes

Abundant

Calamagrostis canadensis
Festuca elatior

Common

Abutilon theophrasti
Brassica kaber
Cirsium arvense
Cornus drummondii
Cyperus ferruginescens
Impatiens capensis
Lycopus americanus
L. europaeus
Polygonum lapathifolium
Populus deltoides
Rhus typhina

Occasional

Amaranthus tuberculatus
Bidens cernua
Carex sp.
Cirsium vulgare
Cuscuta gronovii
Cyperus erythrorhizos
Dipsacus sylvestris
Echinochloa walteri
Ludwigia palustris var. americana
Oenothera biennis
Panicum capillare
P. dichotomiflorum
Penthorum sedoides
Polygonum hydropiper
P. punctatum
Rhus glabra
Scutellaria epilobiifolia
S. lateriflora
Verbena hastata
Vitis riparia

Rare

Apocynum cannabinum
Asclepias incarnata
Aster simplex
Daucus carota
Erechtites hieracifolia
Helenium autumnale
Hibiscus palustris
Mimulus ringens
Polygonum pensylvanicum
Ranunculus sceleratus
Rosa multiflora
Salix fragilis

TABLE A31. Estimated Abundances of Taxa Present in a Fifth Growing Season as Observed on Dike Number 16 (Top and South Slope Only) at Magee Marsh.

Location: 100 feet south of and parallel to the east/west portion of dike number 13
Date of study: 13 September 1976
Disturbances: some brush was removed three years ago
Substrate: firm clay
Seed sources: plants of adjacent marshes

Abundant

Festuca elatior
Rhus typhina

Common

Brassica kaber
Cornus drummondii*
Melilotus alba
Populus deltoides
Rhus glabra
Salix fragilis

Occasional

Abutilon theophrasti
Arctium lappa
Aster simplex
Cirsium arvense
Daucus carota
Dipsacus sylvestris
Euphorbia serpyllifolia
Hordeum jubatum
Medicago lupulina
Oenothera biennis
Panicum dichotomiflorum
Phalaris arundinacea
Phragmites australis
Polygonum aviculare
P. coccineum
P. lapathifolium
Setaria glauca
Vitis riparia

Rare

Amaranthus albus
A. tuberculatus
Asclepias incarnata
Cirsium vulgare
Hibiscus palustris
Mirabilis nyctaginea
Rosa multiflora
Solanum dulcamara
Tragopogon major
Verbena hastata

*Has been along the slopes above the water level for almost ten years.

TABLE A32. Estimated Abundances of Taxa Present in Approximately the Tenth Growing Season as Observed on Dike Number 8 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from Bayview Road; this dike is actually on property owned by Milsite Farms in Castalia, and is situated between two of Moxley's marsh units
Date of study: 7 September 1976
Disturbances: road on top; fluctuation of the water level in the ditch on the west-facing slope
Substrate: firm clay; considerable animal damage
Seed sources: Polygonum lapathifolium was maintained on the west-facing slope because of the fluctuating level of the water in the ditch; the woody species have been established since the early vegetational stages

Abundant

Populus deltoides
Polygonum lapathifolium

Common

Asclepias incarnata
Calamagrostis canadensis
Cirsium arvense
Cornus drummondii

Occasional

Arctium lappa
Dipsacus sylvestris
Festuca elatior
Lythrum salicaria
Oxalis europaea
Salix fragilis

Rare

Salix amygdaloides

TABLE A33. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present after Approximately Ten to Twenty-five Seasons of Growth on Dike Number 20 at Winous Point Shooting Club.

Location: along the west border of MacRitchie Marsh, near Horn's property
Date of study: 4 transects established on 7 July 1977
Disturbances: not significant
Substrate: packed clay, usually remains moist because dike is less than six feet above low water level in the adjacent ditch and marsh
Seed sources: indeterminable

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transects:			
A	Cornus drummondii	72.2	52.3
A	Geum canadense	33.0	31.7
O	Vitis riparia	8.7	2.2
O	Parthenocissus inserta	8.2	2.5
O	Asclepias incarnata	5.4	3.2
R	Oxalis europaea	5.4	1.9
R	Arctium lappa	4.9	1.6
R	Convolvulus sepium	3.0	0.6
R	Rhus radicans	2.0	0.9
R	Rosa sp.	1.5	0.3
R	Alliaria officinalis	1.4	0.3
R	Galium sp.	1.4	0.3
R	Sambucus canadensis	1.2	0.3
R	Quercus palustris	1.0	0.3
Additional taxa observed on dike:			
R	Impatiens capensis		
R	Ribes americanum		

TABLE A34. Estimated Abundances of Taxa Present after More than Twenty-five Growing Seasons as Observed on Dike Number 12 at Moxley's Marsh.

Location: in the northeastern quadrant formed by the intersection of routes 2 and 269; enter from route 269, ¼ mile north of route 2; this dike is parallel to dike number 11
Date of study: 8 September 1976
Disturbances: periodically this dike may become completely inundated
Substrate: firm, but moist; this dike is less than two feet above the level of the water in the adjacent ditches
Seed sources: indeterminable

Abundant

Cornus drummondii
Lonicera japonica

Common

Carex sp.
Vitis riparia

Occasional

Lycopus americanus
Rhus typhina
Salix alba*
Scutellaria epilobiifolia

Rare

Asclepias incarnata
Celtis occidentalis
Cirsium arvense
Fraxinus pennsylvanica
Iris sp.
Leersia oryzoides
Lythrum salicaria
Oenothera biennis
Phalaris arundinacea
Populus deltoides
Quercus borealis
Rumex verticillatus
Scirpus fluviatilis
Ulmus rubra

*This was the dominant species, possibly planted years ago.

TABLE A35. Estimated Abundances, Frequencies, and Relative Densities of Taxa Present after More than Twenty-five Growing Seasons as Observed on Dike Number 21 at Moxley's Marsh.

Location: in the southwestern quadrant formed by the intersection of routes 2 and 269, parallel to route 269 from route 2 to the entrance road to the clubhouse
Date of study: 1 transect was established on 26 July 1977
Disturbances: not significant
Substrate: firm, not much damage, elevated above the adjacent ditches
Seed sources: indeterminable

Estimated Abundance	Name of Plant	Frequency (%)	Relative Density (%)
Taxa recorded from transect:			
A	Parthenocissus inserta	57.8	44.1
A	Cornus racemosa	57.8	31.5
C	Ribes americanum	15.6	5.0
C	Vitis riparia	15.6	2.9
C	Solidago gigantea	11.1	8.4
R	Arctium minus	8.9	2.5
O	Geum canadense	6.7	2.5
R	Cirsium arvense	6.7	1.3
R	Smilacina stellata	4.4	0.8
R	Acalypha rhomboidea	2.2	0.5
R	Sambucus canadensis	2.2	0.5
Additional taxa observed on dike (including comments):			
C	Impatiens capensis, along east facing slope at border of dike and ditch		
O	Lysimachia ciliata		
O	Salix alba, large, old trees; by far the most dominant species		
R	Celtis occidentalis, a few large trees		
R	Rhus radicans		
R	Thalictrum dasycarpum		
R	Ulmus rubra, a few large trees		
R	Verbena urticifolia		

APPENDIX B

Catalogue of the Taxa on the Dikes of the Marshes of Northwestern Ohio

A catalogue of 194 taxa of vascular plants was prepared from the lists of plants in the tables of Appendix A. The taxa in this catalogue, mostly species, are arranged alphabetically by scientific name. One common name is included for each taxon. Also included are the names of the marshes* and the numbers of the dikes where the taxa were observed. The total number of dikes on which a taxon was observed is included as an approximation of the abundance of the taxon. Non-indigenous taxa are indicated by an asterisk preceding the scientific name.

*MA=Magee Marsh, MO=Moxley's Marsh, and WI=Winous Point Shooting Club.

APPENDIX B., continued

MA	MO	WI	TAXA
X	X	X	*Abutilon theophrasti Medic., Velvet-leaf 13 dikes; numbers 4, 5, 7, 9, 10, 13, 14, 15, 16, 17, 18, 19, 22.
X	X	X	Acalypha rhomboidea Raf., Three-seeded Mercury 5 dikes; numbers 4, 5, 19, 21, 22.
X		X	Acer negundo L., Ash-leaved Maple 3 dikes; numbers 2, 6, 22.
	X		Acer saccharinum L., Silver Maple 1 dike; number 10.
X		X	Agrimonia L. sp., Agrimony 2 dikes; numbers 14, 19.
		X	Alisma plantago-aquatica L., Water-plantain 1 dike; number 4.
		X	*Alliaria officinalis Andrz., Garlic-mustard 4 dikes; numbers 5, 6, 19, 20.
X			*Amaranthus albus L., Tumbleweed 2 dikes; numbers 16, 22.
X			*Amaranthus graecizans L., Tumbleweed 2 dikes; numbers 13, 14.
	X	X	*Amaranthus retroflexus L., Pigweed 4 dikes; numbers 5, 6, 7, 10.
X	X		Amaranthus tuberculatus (Moq.) Sauer, Water-hemp 5 dikes; numbers 9, 10, 13, 15, 16.
X		X	Ambrosia artemisiifolia L., Common Ragweed 4 dikes; numbers 13, 14, 18, 19.
	X	X	Ambrosia trifida L., Great Ragweed 3 dikes; numbers 9, 17, 19.
X	X	X	Apocynum cannabinum L., Indian Hemp 8 dikes; numbers 3, 4, 5, 9, 11, 15, 17, 22.
X	X	X	*Arctium lappa L., Burdock 15 dikes; numbers 2, 4, 5, 6, 8, 9, 11, 13, 14, 15, 16, 17, 18, 19, 20.

APPENDIX B., continued

MA	MO	WI	TAXA
	X		*Arctium minus (Hill) Bernh., Common Burdock 1 dike; number 21.
X	X	X	Asclepias incarnata L., Swamp Milkweed 19 dikes; numbers 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22.
X		X	Asclepias syriaca L., Common Milkweed 4 dikes; numbers 13, 14, 17, 19.
		X	Aster novae-angliae L., New England Aster 1 dike; number 19.
X		X	Aster simplex Willd., Aster 5 dikes; numbers 3, 15, 16, 17, 19.
		X	Aster L. sp., Aster 3 dikes; numbers 4, 18, 19.
X		X	Atriplex patula L. var. hastata (L.) Gray, Orach 5 dikes; numbers 5, 13, 14, 18, 22.
X			Atriplex patula L. var. patula L., Orach 1 dike; number 14.
		X	*Barbarea vulgaris R. Br., Winter Cress 2 dikes; numbers 17, 19.
X		X	Bidens cernua L., Beggar-ticks 6 dikes; numbers 5, 13, 14, 15, 16, 22.
		X	Bidens connata Muhl., Beggar-ticks 2 dikes; numbers 5, 19.
X		X	Bidens frondosa L., Beggar-ticks 6 dikes; numbers 4, 5, 14, 17, 18, 19.
X	X	X	*Brassica kaber (DC.) L. C. Wheeler, Charlock 14 dikes; numbers 3, 4, 5, 6, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19.
X	X	X	Calamagrostis canadensis (Michx.) Nutt., Blue-joint Grass 4 dikes; numbers 4, 8, 9, 13.
	X		*Carduus nutans L., Nodding Thistle 2 dikes; numbers 9, 11.

APPENDIX B., continued

MA	MO	WI	TAXA
X	X	X	Carex L. sp., Sedge 7 dikes; numbers 2, 4, 5, 6, 12, 13, 15.
	X	X	Celtis occidentalis L., Hackberry 3 dikes; numbers 6, 12, 21.
X		X	*Chaenorrhinum minus (L.) Lange, Dwarf Snapdragon 2 dikes; numbers 18, 22.
X	X	X	*Chenopodium album L., Lamb's-quarters 6 dikes; numbers 4, 9, 10, 13, 17, 18.
		X	Circaea quadrisulcata (Maxim.) Franch. & Sav., Enchanter's Nightshade 1 dike; number 5.
	X	X	*Cichorium intybus L., Chicory 3 dikes; numbers 9, 18, 19.
X	X	X	*Cirsium arvense (L.) Scop., Canada Thistle 19 dikes; numbers 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22.
X	X	X	*Cirsium vulgare (Savi) Tenore, Bull Thistle 7 dikes; numbers 4, 7, 13, 15, 16, 19, 22.
X	X	X	Convolvulus sepium L., Hedge Bindweed 16 dikes; numbers 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 17, 18, 19, 20, 22.
X	X	X	Cornus drummondii Meyer, Rough-leaved Dogwood 12 dikes; numbers 3, 4, 5, 6, 8, 9, 12, 13, 15, 16, 19, 20.
	X		Cornus racemosa Lam., Dogwood 1 dike; number 21.
	X		Cornus L. sp., Dogwood 1 dike; number 9.
X	X	X	Cuscuta gronovii Willd., Dodder 8 dikes; numbers 2, 5, 6, 9, 10, 11, 13, 15.
X		X	Cyperus erythrorhizos Muhl., Umbrella Sedge 8 dikes; numbers 4, 5, 13, 14, 15, 16, 18, 22.

APPENDIX B., continued

MA	MO	WI	TAXA
	X		Cyperus esculentus L., Yellow Nut-grass 1 dike; number 10.
X	X	X	Cyperus ferruginescens Boeckl., Umbrella Sedge 9 dikes; numbers 4, 5, 10, 13, 14, 15, 16, 18, 22.
X	X	X	Cyperus strigosus L., Umbrella Sedge 3 dikes; numbers 5, 7, 14.
	X	X	*Dactylis glomerata L., Orchard Grass 2 dikes; numbers 9, 17.
X	X	X	*Daucus carota L., Wild Carrot 8 dikes; numbers 4, 11, 14, 15, 16, 17, 18, 19.
X		X	*Digitaria sanguinalis (L.) Scop., Crab Grass 2 dikes; numbers 14. 19.
X	X	X	*Dipsacus sylvestris Huds., Teasel 10 dikes; numbers 3, 4, 8, 9, 11, 13, 15, 16, 17, 19.
	X		*Echinochloa crus-galli (L.) Beauv., Barnyard Grass 1 dike; number 10.
X	X	X	Echinochloa pungens (Poir.) Rydb., Barnyard Grass 9 dikes; numbers 4, 5, 7, 9, 11, 13, 14, 16, 22.
X	X	X	*Echinochloa walteri (Pursh) Nash, Walter's Millet 13 dikes; numbers 2, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 18, 22.
		X	Eclipta alba (L.) Hassk., Pie-plate-plant 1 dike; number 5.
X			Elymus virginicus L., Virginia Wild Rye 1 dike; number 4.
		X	Epilobium glandulosum Lehm., Willow-herb 1 dike; number 3.
	X		*Epilobium hirsutum L., Great Hairy Willow-herb 1 dike; number 11.
X		X	Eragrostis hypnoides (Lam.) BSP., Love Grass 2 dikes; numbers 13, 17.

APPENDIX B., continued

MA	MO	WI	TAXA
		X	Gleditsia triacanthos L., Honey-locust 2 dikes; numbers 4, 19.
X			Helenium autumnale L., Sneezeweed 1 dike; number 15.
X	X	X	Hibiscus palustris L., Swamp Rose Mallow 16 dikes; numbers 2, 3, 4, 5, 6, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 22.
X		X	*Hibiscus trionum L., Flower-of-an-hour 4 dikes; numbers 5, 13, 18, 22.
X		X	*Hordeum jubatum L., Squirrel-tail Grass 4 dikes; numbers 13, 16, 17, 19.
X	X	X	Impatiens capensis Meerb., Spotted Jewelweed 16 dikes; numbers 3, 4, 5, 6, 7, 9, 10, 11, 14, 15, 16, 17, 19, 20, 21, 22.
X			*Ipomoea purpurea (L.) Roth, Common Morning-glory 1 dike; number 13.
	X		Iris L. sp., Iris 1 dike; number 12.
	X	X	*Lactuca scariola L., Prickly Lettuce 3 dikes; numbers 9, 17, 19.
X			Lactuca L. sp., Lettuce 1 dike; number 9.
X	X	X	Leersia oryzoides (L.) Sw., Rice Cutgrass 8 dikes; numbers 3, 4, 7, 9, 10, 12, 14, 18.
		X	*Lepidium campestre (L.) R. Br., Peppergrass 1 dike; number 17.
X			Lepidium virginicum L., Peppergrass 1 dike; number 14.
	X	X	*Lonicera japonica Thunb., Japanese Honeysuckle 2 dikes; numbers 6, 12.
	X		*Lolium multiflorum Lam., Italian Rye Grass 1 dike; number 10.

APPENDIX B., continued

MA	MO	WI	TAXA
X			*Lotus corniculatus L., Birdsfoot Trefoil 1 dike; number 14.
X			Ludwigia palustris (L.) Ell. var. americana (DC.) Fern. & Grisc., Water-pusrlane 2 dikes; numbers 15, 16.
		X	*Lycopersicon esculentum Mill., Tomato 1 dike; number 5.
X	X	X	Lycopus americanus Muhl., Water Horehound 13 dikes; numbers 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 17, 19, 22.
X		X	*Lycopus europaeus L., European Water Horehound 5 dikes; numbers 4, 5, 6, 13, 15.
	X	X	Lysimachia ciliata L., Loosestrife 2 dikes; numbers 5, 21.
		X	*Lysimachia nummularia L., Moneywort 2 dikes; numbers 6, 17.
	X		*Lythrum salicaria L., Purple Loosestrife 5 dikes; numbers 7, 8, 9, 10, 12.
X	X	X	*Medicago lupulina L., Black Medick 9 dikes; numbers 4, 5, 9, 13, 14, 16, 18, 19, 22.
X	X	X	*Melilotus alba Desr., White Sweet Clover 10 dikes; numbers 3, 4, 5, 6, 9, 11, 13, 16, 17, 19.
X		X	*Melilotus officinalis (L.) Lam., Yellow Sweet Clover 4 dikes; numbers 3, 4, 18, 22.
		X	*Melilotus Mill. spp., Sweet Clovers 3 dikes; numbers 4, 5, 19.
		X	Mentha arvensis L., Mint 1 dike; number 17.
		X	*Mentha piperita L., Peppermint 3 dikes; numbers 4, 5, 6.
X			Mimulus ringens L., Monkey-flower 1 dike; number 15.

APPENDIX B., continued

MA	MO	WI	TAXA
X		X	*Mirabilis nyctaginea (Michx.) MacM., Four-o'clock 2 dikes; numbers 16, 17.
	X		*Nepeta cataria L., Catnip 2 dikes; numbers 9, 11.
X	X	X	Oenothera biennis L., Evening Primrose 16 dikes; numbers 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20.
X		X	Oxalis europaea Jord., Wood Sorrel 9 dikes; numbers 4, 5, 6, 8, 14, 16, 17, 19, 20.
X	X	X	Panicum capillare L., Old-witch Grass 9 dikes; numbers 4, 7, 9, 10, 11, 13, 14, 15, 16.
X		X	Panicum dichotomiflorum Michx., Panic Grass 6 dikes; numbers 5, 13, 14, 15, 16, 18.
X			Panicum lanuginosum Ell., Panic Grass 1 dike; number 14.
X	X	X	Parthenocissus inserta (Kerner) K. Fritsch, Virginia Creeper 9 dikes; numbers 3, 4, 5, 6, 13, 17, 19, 20, 21.
X			Penthorum sedoides L., Ditch Stonecrop 2 dikes; numbers 15, 22.
X	X	X	Phalaris arundinacea L., Reed Canary Grass 12 dikes; numbers 3, 4, 5, 6, 9, 10, 12, 13, 16, 17, 18, 19.
X	X	X	Phragmites australis (Cav.) Trin. ex Steud., Reed 7 dikes; numbers 4, 5, 6, 9, 10, 11, 16.
		X	*Physalis alkekengi L., Chinese Lantern-plant 1 dike; number 4.
		X	Physalis virginiana Mill., Ground-cherry 1 dike; number 19.
X	X	X	Phytolacca americana L., Pokeweed 5 dikes; numbers 4, 10, 11, 13, 18.

APPENDIX B., continued

MA	MO	WI	TAXA
		X	Pilea pumila (L.) Gray, Clearweed 1 dike; number 6.
X		X	Plantago rugellii Dcne., Plantain 4 dikes; numbers 5, 17, 19, 22.
X		X	Poa pratensis L., Kentucky Bluegrass 4 dikes; numbers 13, 17, 18, 19.
X			Polanisia dodecandra (L.) DC., Clammyweed 1 dike; number 14.
X		X	*Polygonum aviculare L., Knotweed 5 dikes; numbers 9, 14, 16, 17, 22.
X	X	X	Polygonum coccineum Muhl., Smartweed 12 dikes; numbers 2, 4, 5, 6, 9, 10, 13, 14, 16, 17, 19, 22.
X		X	Polygonum hydropiper L., Common Smartweed 3 dikes; numbers 5, 14, 15.
X	X	X	Polygonum lapathifolium L., Nodding Smartweed 13 dikes; numbers 2, 4, 5, 7, 8, 9, 10, 13, 14, 15, 16, 18, 22.
X	X	X	Polygonum pensylvanicum Small, Pinkweed 12 dikes; numbers 3, 4, 5, 7, 9, 11, 13, 14, 15, 16, 18, 22.
		X	*Polygonum persicaria L., Lady's-thumb 2 dikes; numbers 4, 5.
X		X	Polygonum punctatum Ell., Water Smartweed 5 dikes; numbers 3, 4, 5, 13, 15.
X		X	Polygonum scandens L., Climbing False Buckwheat 2 dikes; numbers 3, 14.
X	X	X	Populus deltoides Marsh., Cottonwood 14 dikes; numbers 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 16, 17, 18.
	X		Quercus borealis Michx. f., Red Oak 1 dike; number 12.

APPENDIX B., continued

MA	MO	WI	TAXA
		X	Quercus palustris Muenchh., Pin Oak 2 dikes; numbers 6, 20.
		X	Ranunculus abortivus L., Kidneyleaf Buttercup 1 dike; number 5.
X		X	Ranunculus sceleratus L., Cursed Crowfoot 3 dikes; numbers 5, 15, 16.
X		X	Rhus glabra L., Smooth Sumac 4 dikes; numbers 3, 6, 15, 16.
	X	X	Rhus radicans L., Poison Ivy 4 dikes; numbers 6, 19, 20, 21.
X	X	X	Rhus typhina L., Staghorn Sumac 13 dikes; numbers 3, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 22.
	X	X	Ribes americanum Mill., Wild Black Currant 4 dikes; numbers 3, 5, 20, 21.
		X	Rorippa palustris (L.) Bess. var. hispida (Desv.) Rydb., Marsh Cress 1 dike; number 5.
		X	*Rorippa sylvestris (L.) Bess., Creeping Yellow Cress 1 dike; number 6.
X			*Rosa multiflora Thunb., Rose 2 dikes; numbers 15, 16.
		X	Rosa L. sp., Rose 2 dikes; numbers 4, 20.
		X	Rubus L. sp., Bramble 1 dike; number 5.
X	X	X	*Rumex crispus L., Curly Dock 11 dikes; numbers 3, 4, 5, 6, 9, 12, 13, 15, 16, 17, 19.
	X		*Rumex maritimus L., Dock 1 dike; number 10.
		X	Sagittaria latifolia Willd., Arrowhead 1 dike; number 5.

APPENDIX B., continued

MA	MO	WI	TAXA
	X		*Salix alba L., White Willow 2 dikes; numbers 12, 21.
	X		Salix amygdaloides Anderss., Peach-leaved Willow 3 dikes; numbers 8, 10, 11.
X	X	X	*Salix fragilis L., Crack Willow 6 dikes; numbers 5, 8, 9, 11, 15, 16.
	X	X	Salix interior Rowlee, Sandbar Willow 4 dikes; numbers 2, 11, 17, 19.
X			Salix rigida Muhl., Willow 1 dike; number 13.
	X		Salix L. sp., Willow 2 dikes; numbers 9, 10.
	X	X	Sambucus canadensis L., Common Elderberry 11 dikes; numbers 2, 3, 4, 6, 9, 10, 11, 17, 19, 20, 21.
X	X	X	Scirpus fluviatilis (Torr.) Gray, River Bulrush 4 dikes; numbers 4, 5, 12, 14.
X			Scirpus validus Vahl, Soft-stem Bulrush 1 dike; number 14.
		X	Scirpus L. sp., Bulrush 1 dike; number 3.
X	X	X	Scutellaria epilobiifolia A. Hamilton, Common Skullcap 10 dikes; numbers 4, 5, 6, 9, 10, 11, 12, 13, 15, 16.
X		X	Scutellaria lateriflora L., Mad-dog Skullcap 4 dikes; numbers 5, 6, 15, 19.
X			*Setaria faberii Herrm., Bristly Foxtail 1 dike; number 13.
X			*Setaria glauca (L.) Beauv., Foxtail 1 dike; number 16.
X	X	X	*Setaria viridis (L.) Beauv., Green Foxtail 6 dikes; numbers 9, 11, 13, 14, 18, 19.
	X		Sicyos angulatus L., Bur-cucumber 1 dike; number 11.

APPENDIX B., continued

MA	MO	WI	TAXA
	X		Smilacina stellata (L.) Desf., Starry False Solomon's-seal 1 dike; number 21.
		X	Solanum carolinense L., Horse-nettle 2 dikes; numbers 3, 5.
X	X	X	*Solanum dulcamara L., Bittersweet Nightshade 9 dikes; numbers 2, 3, 4, 7, 9, 11, 13, 16, 18.
X	X	X	*Solanum nigrum L., Nightshade 6 dikes; numbers 5, 7, 9, 10, 13, 16.
	X		Solidago gigantea Ait., Goldenrod 1 dike; number 21.
X		X	Solidago nemoralis Ait., Goldenrod 2 dikes; numbers 4, 13.
		X	Solidago L. sp., Goldenrod 3 dikes; numbers 4, 17, 19.
X	X		*Sonchus asper (L.) Hill, Spiny-leaved Sow-thistle 3 dikes; numbers 9, 11, 14.
X	X	X	*Sonchus uliginosus Bieb., Sow-thistle 4 dikes; numbers 4, 11, 17, 19.
X			*Sonchus L. sp., Sow-thistle 1 dike; number 13.
X		X	Sparganium eurycarpum Engelm., Bur-reed 4 dikes; numbers 4, 5, 17, 22.
		X	Stachys tenuifolia Willd., Hedge-nettle 3 dikes; numbers 4, 17, 19.
X	X	X	Strophostyles helvola (L.) Ell., Wild Bean 8 dikes; numbers 3, 4, 5, 7, 11, 13, 14, 19.
X		X	*Taraxacum officinale Weber, Dandelion 6 dikes; numbers 5, 9, 14, 17, 18, 19.
X	X	X	Teucrium canadense L., Germander 3 dikes; numbers 6, 9, 14.

APPENDIX B., continued

MA	MO	WI	TAXA
	X		Thalictrum dasycarpum Fisch. & Lall., Purple Meadow-rue 1 dike; number 21.
		X	*Thlaspi arvense L., Field Penny Cress 4 dikes; numbers 3, 5, 18, 19.
X			*Tragopogon major Jacq., Goat's-beard 1 dike; number 16.
		X	*Tragopogon pratensis L., Goat's-beard 1 dike; number 17.
		X	*Trifolium pratense L., Red Clover 1 dike; number 19.
X		X	*Trifolium repens L., White Clover 2 dikes; numbers 14, 19.
		X	Triosteum perfoliatum L., Wild Coffee 1 dike; number 6.
X	X	X	Typha angustifolia L., Narrow-leaved Cat-tail 5 dikes; numbers 7, 9, 14, 18, 19.
		X	Typha latifolia L., Broad-leaved Cat-tail 1 dike; number 6.
		X	Typha L. sp., Cat-tail 1 dike; number 18.
	X		Ulmus rubra Muhl., Slippery Elm 2 dikes; numbers 12, 21.
	X		*Verbascum thapsus L., Common Mullein 1 dike; number 11.
X	X	X	Verbena hastata L., Blue Vervain 13 dikes; numbers 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 22.
	X		Verbena urticifolia L., White Vervain 1 dike; number 21.

APPENDIX B., continued

MA	MO	WI	TAXA
X	X	X	Vitis riparia Michx., River-bank Grape 15 dikes; numbers 3, 4, 5, 6, 9, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21.
		X	*Xanthium strumarium L., Cocklebur 1 dike; number 18.

APPENDIX C

Species Representative of the Dike Flora from Lowden (1967 and 1969)

Woody species

-Catalpa speciosa*
Cephalanthus occidentalis
Cornus drummondii
-Crataegus mollis
Fraxinus pennsylvanica
-Morus alba
Rhus glabra
Rhus typhina
Ribes americanum
Rosa setigera
Salix interior
Sambucus canadensis

(Salix nigra was not included in this list. It was mentioned in the text.)

Herbaceous species

Abutilon theophrasti
Alliaria officinalis
Ambrosia trifida
Apocynum cannabinum
Arctium lappa
Asclepias incarnata
Asclepias syriaca
Aster novae-angliae
-Aster pilosus
Barbarea vulgaris
Brassica kaber
-Bromus commutatus
-Bromus inermis
-Bromus tectorum
Cirsium arvense
-Clematis virginiana
Cyperus esculentus
-Datura stramonium
Dipsacus sylvestris
Echinochloa crus-galli
Echinochloa walteri
Elymus virginicus
Epilobium glandulosum
Erechtites hieracifolia
-Erigeron canadensis
Euphorbia maculata
-Erysimum repandum
Gaura biennis
Hibiscus trionum
Hordeum jubatum
Impatiens capensis
Lepidium campestre
-Lolium perenne
-Lychnis alba
-Lythrum alatum
Medicago lupulina
Melilotus alba
Melilotus officinalis
Mirabilis nyctaginea
Nepeta cataria
Oenothera biennis
Phalaris arundinacea
Phytolacca americana
Polygonum coccineum
-Polygonum convolvulus
Polygonum lapathifolium
Polygonum pensylvanicum
Polygonum punctatum
-Polygonum sagittatum
Polygonum scandens
Rumex crispus
-Scrophularia marilandica
Scutellaria epilobiifolia
Scutellaria lateriflora
-Silene notiflora
Solanum carolinense
Solanum dulcamara
Sonchus asper
Sonchus uliginosus
Stachys tenuifolia
Teucrium canadense
Thlaspi arvense
Verbena hastata

Apocynum cannabinum, Phalaris arundinacea, Populus deltoides, Salix nigra, and Scutellaria epilobiifolia were listed as "prominent components of the dike flora."

*Species preceded by a dash (-) were not recorded for the flora of the dikes in 1976 and 1977.