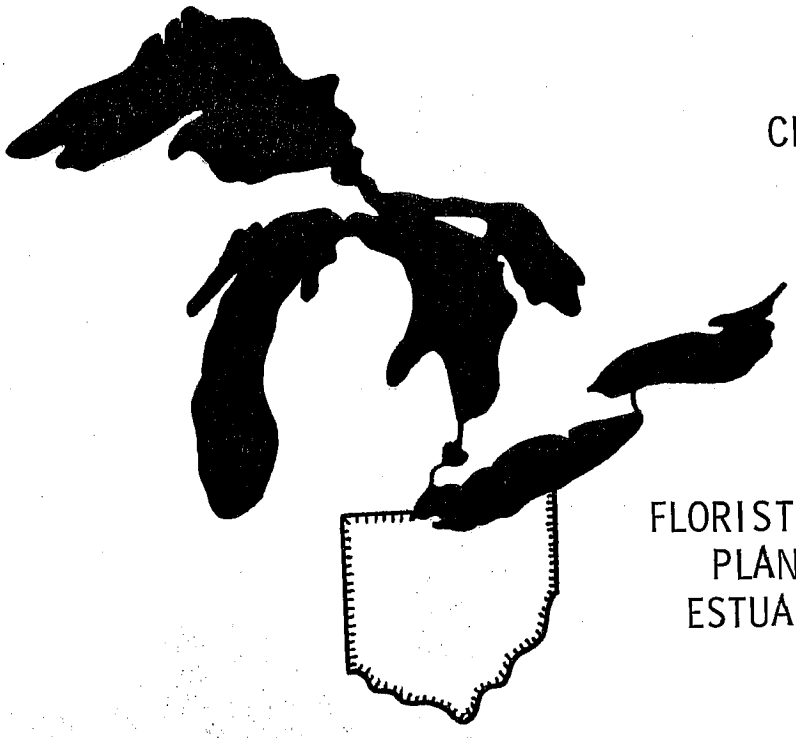

CLEAR TECHNICAL REPORT NO. 67

FLORISTIC ANALYSIS OF THE VASCULAR PLANTS OF THE OLD WOMAN CREEK ESTUARY AND CONTIGUOUS UPLANDS ERIE COUNTY, OHIO

by

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Prepared for

Division of Water
Ohio Department of Natural Resources
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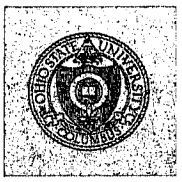
THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

July 1977



THE OHIO STATE UNIVERSITY

PREFACE

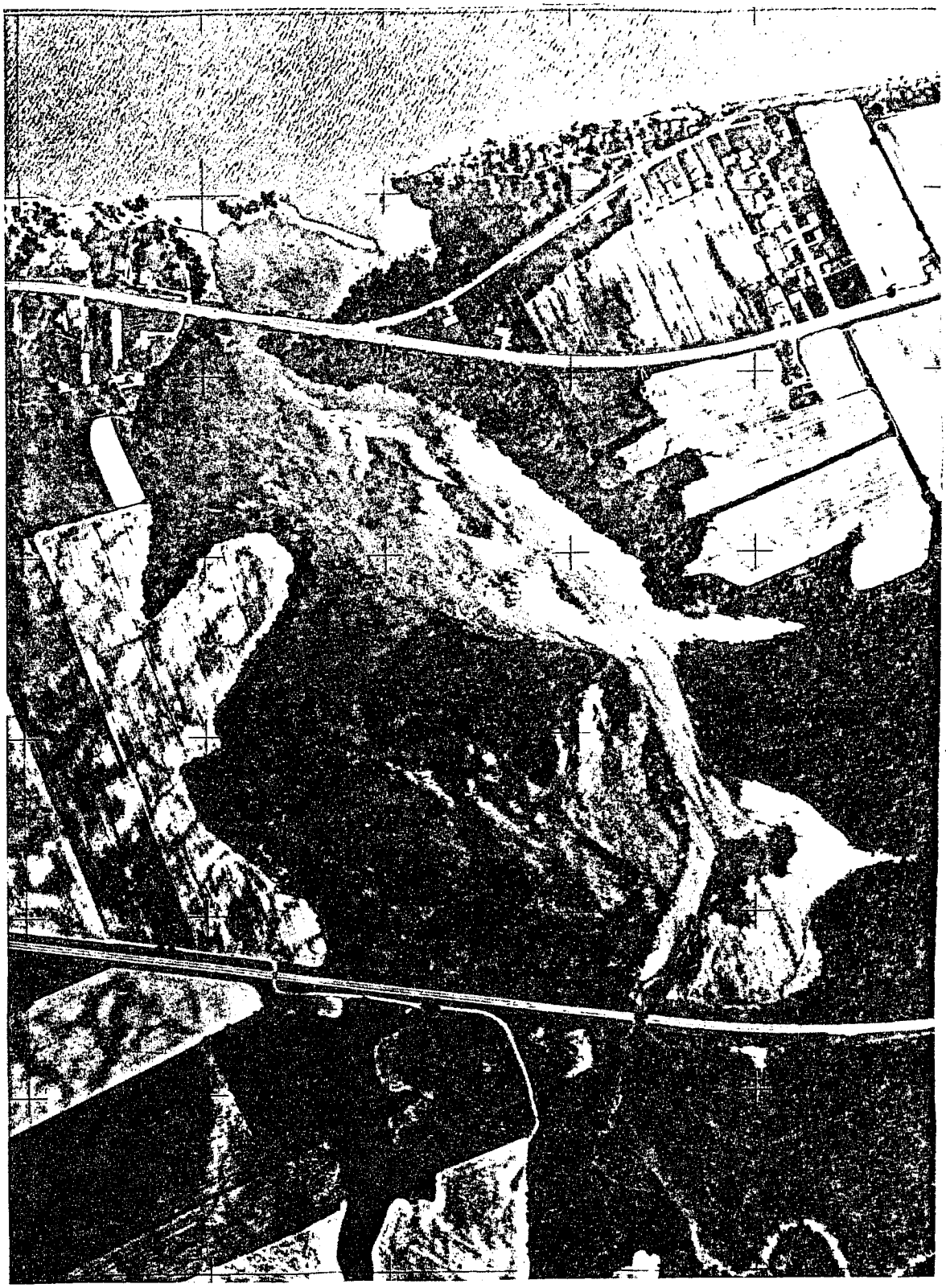
The following report was prepared by John H. Marshall as partial fulfillment for a M.S. degree in the Department of Botany. Research conducted for this thesis was part of a project coordinated by the Center for Lake Erie Area Research (CLEAR) at The Ohio State University and was in part sponsored by the Ohio Department of Natural Resources (Grant No. DNR-RS-4). Dr. Ronald L. Stuckey, Department of Botany, served as advisor; other members of the reading and examination committee were Drs. Charles E. Herdendorf, Department of Zoology and Emanuel D. Rudolph, Clarence E. Taft and Tod F. Stuessy, Department of Botany.

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
July 2, 1977

Center for Lake Erie Area Research / Biological Sciences Bldg. / 484 West Twelfth Avenue / Columbus, Ohio 43210 / Phone (614) 422-8949

AERIAL PHOTOGRAPH OF THE OLD WOMAN CREEK ESTUARY AND CONTIGUOUS UPLANDS



FRONTISPIECE

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Sincere thanks are extended to the following:

Ronald L. Stuckey, my adivsor who gave freely his time, knowledge and experience. Without his observations and source of references this study would be far from complete.

Dr. Charles E. Herdendorf, Director of the Center for Lake Erie Area Research (CLEAR) and the Franz Theodore Stone Laboratory who arranged with the Ohio Department of Natural Resources for the grant supporting the research in this study and for use of equipment and various facilities.

Mr. Dennis Case, then Chief of the Division of Research, Ohio Department of Natural Resources, who made the grant (Project No. DNR-RS-4) to CLEAR.

The Oberlin Beach Association, Mrs. Marilyn Hooper, President, and Mr. Stephen Cool for access to the Old Woman Creek Estuary.

Mr. and Mrs. Charles Harley for the use of their dock, their encouragement and their assistance in obtaining historical information connected with the estuary.

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INTRODUCTION

Old Woman Creek, a drowned stream mouth covering an area of 0.3 km^2, on the south shore of Lake Erie, lies one mile east of Huron in Erie County, Ohio. It is considered as a freshwater estuary as characterized by Brant and Herdendorf (1972). The term estuary in general is applied to a body of water in which river water mixes and measurably dilutes sea water. It also has been described as the mouth of a river or arm of the sea where the tide meets the river currents, or flows and ebbs (Reid, 1961). However, Brant and Herdendorf (1972) proposed that the term estuary be applied to the drowned portion of rivers and streams entering Lake Erie, as "the common denominator in virtually all definitions of estuaries is the morphology, morphometery and the hydraulic relation of the water level therein contained to the entering stream." The estuary and its contiguous uplands (the study area) remain one of the few undeveloped areas on Ohio's Lake Erie shoreline. It is currently under consideration for designation as an estuarine sanctuary, under the auspices of the Coastal Zone Management Act of 1972.

To date little has been known of the floristics of the Old Woman Creek area. E. L. Moseley (1899) was interested in the flowering plants and ferns growing without cultivation, in Erie County, Ohio, and the peninsula and islands of Ottawa County, Ohio. Old Woman Creek was therefore only a small part of Moseley's concern

and for the most part his work in the estuary is not known. His catalogue of the plants of Erie County, however, is useful in interpreting certain aspects of the present flora in the estuary. During the latter 1960's and early 1970's, G. T. Jones of Oberlin College collected plants in the vicinity of Old Woman Creek, concentrating primarily on and around the railroad in the uplands. Again, his collections represent only a portion of the flora of the Old Woman Creek Estuary and contiguous uplands.

Because little is known of the components of the Old Woman Creek Estuary ecosystem, it is well to first study the area with baseline surveys, which serve as a basis for subsequent study. Considering the scarcity of undeveloped freshwater estuaries on Ohio's Lake Erie shoreline, Old Woman Creek Estuary becomes a valuable study site for many disciplines within the physical and biological sciences.

The objectives of the present study are to:

1. make an inventory of all known vascular plants in the estuary and contiguous non-agricultural uplands throughout three growing seasons,

2. prepare a vegetation map of the area showing the various types of communities and the dominant vegetation zones,

3. determine the influence of present hydrologic conditions on the vegetation of the estuary,

4. analyze the flora with regard to geographical relationships, species diversity, flowering phenology and the degree to which environmental alteration has influenced species composition.

Figure 1. Reference Stations in the Old Woman Creek Study Area

Key:

I, II, III, IV, V.....Open water stations.

A, B, C, D, E.....Embayment marshes.

BB.....Barrier beach.

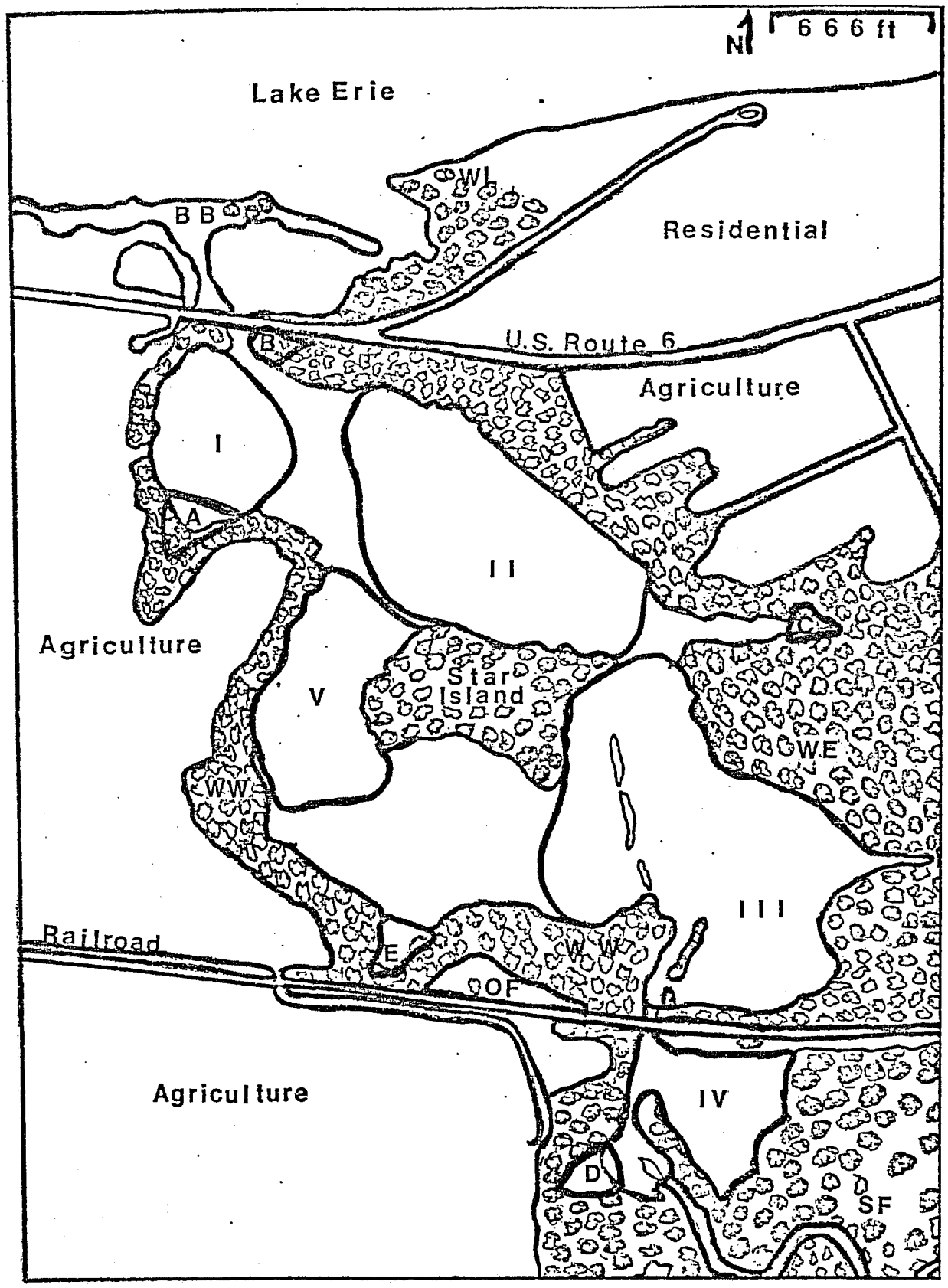
OF.....Old Field

SF.....Swamp forest.

WE.....Eastern woodlands.

WW.....Western woodlands.

WL.....Lake front woodlands.


N
666 ft
Lake Erie
WL
BB
Residential
U.S. Route 6
B
Agriculture
I
A
II
Agriculture
V
Star Island
WE
WW
III
Railroad
E
WW
OOF
D
Agriculture
IV
D
SF

METHODS

Field data collection on the plants in the Old Woman Creek Estuary extended from 15 June through 15 September, 1974; 10 May through 15 September, 1975 and 12 June through 20 September, 1976. These data included information on relative abundance, phenology and location of the vascular plants of the estuary and contiguous uplands. Voucher specimens are deposited in The Ohio State Univer- Herbarium to substantiate the catalog of the flora in the appendix.

Field work during the 1974 growing season concentrated on the aquatic vascular plants of the estuary. During the 1975 and 1976 seasons data gathering concentrated on the upland areas with regular surveys of the aquatic flora, as well. A work sheet was kept for each of the major vegetation zones. Information recorded on the work sheets included species occurring within each station and their abundance relative to other species occurring at that site. Throughout the study period, photographs of macro- and micro-habitats were taken, some of which are reproduced in this thesis. An aerial photograph used in conjunction with the work sheets was employed in the construction of the ground cover vegetation map.

Identification of specimens followed the use of The New Britton and Brown Illustrated Flora of the Northwestern United States and Adjacent Canada, (Gleason, 1952), A Manual of Aquatic Plants

(Fassett, 1957), Gray's Manual of Botany (Fernald, 1950), The Monocotyledoneae [of Ohio] (Braun, 1967) and the Woody Plants of Ohio (Braun, 1961). The identification of many specimens was facilitated by comparison with identified specimens in The Ohio State University Herbarium.

PHYSICAL ENVIRONMENT

Climate

Actual climatological data are not available for the Old Woman Creek Estuary. However, the climate may be inferred from data recorded at the Sandusky station of the United States Department of Commerce, Environmental Services Administration.

Old Woman Creek enters Lake Erie in north central Ohio. The climate of this region is marked by large fluctuations in temperature and precipitation. Because of the proximity to the lake, winds from the north tend to lower daily high temperatures in the summer, while raising the daily low temperatures in the winter. The growing season at Old Woman Creek averages 198 days, the average of the period between the last freezing temperature of spring and the first freezing temperature of autumn. The warming or tempering effect of the lake is evident when one considers the growing season at the Erie-Huron County line, seven miles south of the lake. At that point the growing season averages only 165 days.

Summers in the area are moderately warm and humid with approximately 16 days when temperatures exceed 89 degrees. Winters are generally cold and cloudy. However, the tempering effect of the lake allows for only three of five winters in which subzero temperatures occur. This area experiences weather changes every few days because of passing fronts and their associated centers of high and low pressure (Miller, 1969).

of high and low pressure (Miller, 1969).

As is common for continental climates, precipitation is highly variable on a yearly basis. However, precipitation is generally abundant and well distributed, with autumn being the driest season. Average annual precipitation for the area is approximately 89 centimeters (Sanderson, 1950). Annual prevailing winds are southwesterly and average 7 knots in the summer and 10 knots in the winter (Miller, 1969). The area has a history of severe storms which have caused extensive damage to shoreline.

Hydrology

Old Woman Creek has an elevation of 252 meters at its source, from which it meanders 16 kilometers with a fall of 78 meters to an elevation of 174 meters at its mouth on the Lake Erie shoreline, or an average gradient of 4.88 meters per kilometer. The stream drains 78.74 square kilometers of Erie and Huron Counties. Within the drainage area, the primary land use is agriculture, and surface runoff from this type of watershed carries a heavy silt load causing the stream to remain quite turbid throughout most of the year.

Because of high water levels in Lake Erie in recent years and the low-lying floodplain of the stream, the former marshlands of the estuary have been submerged. This submergence has resulted in a flooded area of approximately 30 hectares, affecting water levels in the stream as far as 2.9 kilometers from the mouth (Brant and Herdendorf, 1972).

Geology

Old Woman Creek occupies a valley partially filled with glacial till. This valley may have been the preglacial course of the northward flowing Huron River. The upper course of the stream has cut through the Berea Sandstone escarpment, while the lower course has cut through glacial till and lacustrian deposits down to the Huron Shale bedrock. Interlaminations of silt and clay are visible at the mouth of the stream indicating the cyclic sedimentation of a glacial lake greater in size than Lake Erie (Herdendorf, 1963a).

A 518 meter barrier beach with a maximum vertical depth of 7 meters stretches across the mouth of the stream. This barrier is 30 meters wide on its eastern projection and expands to 60 meters on the western end. The beach is composed of course-to-medium-grained sand dominated by quartz with patches of red garnet and black magnetite (Herdendorf, 1963b).

THE STUDY AREA

Old Woman Creek Estuary and its contiguous non-agricultural uplands (the study area) comprise approximately 400 hectares (Figure 1). The stream and its floodplain provide about 160 hectares of aquatic and wetland habitat. The outlying 240 hectares are composed of mixed hardwood forest, an old field, and a barrier sand beach. Extending across the estuary are United States route 6 and the Penn Central Railroad (now Conrail).

Aquatic and wetland habitats within the estuary are quite distinctive one from the other, both in physical and vegetational terms. Physical distinctions include differences in slope, water level fluctuation, sunlight received and exposure to wind and wave action. The species composition and their relative abundance to each aquatic and wetland plant community is discussed in Marshall and Stuckey (1974). The barrier beach supports several vegetation types, ranging from a xerophytic community on its high, well drained center portion to a marsh community along its western border. The species composition of the hardwood forest, composed largely of Quercus alba, Carya ovata, Sassafras albidum, Acer saccharinum, and Acer rubrum, is relatively uniform. Other terrestrial habitats are quite distinctive with regard to vegetational composition. The old field northwest of the railroad trestle is unique because of its prairie vegetation. The margins of United

States route 6 and the railroad embankment represent yet another type of terrestrial habitat, composed primarily of non-indigenous taxa.

Aquatic and Wetland Habitats

Within the estuary, four aquatic and wetland habitat types currently exist. These include open water, shoreline, remnant embayment marshes and mudflats. Owing to current high water levels in Lake Erie, the open water habitat presently includes the stream and its entire floodplain. Aquatic vascular plants in this habitat are Nelumbo lutea, Nuphar advena, Numphaea tuberosa, Peltandra virginica, Ceratophyllum demersum, Potamogeton nodosus, Potamogeton pectinatus, Lemna minor and Spirodela polyrhiza.

The shoreline habitat exists at the interface of the open water and the steep banks which define the floodplain of the estuary, as well as the perimeter of the barrier beach. Dominant species of this habitat type include Cephalanthus occidentalis, Cornus drummondi, Iris versicolor, Lysimachia nummularia, Sagittaria latifolia, Scirpus fluviatilis, Sparganium eurycarpum, and Typha latifolia. While none of these species are particularly abundant throughout the estuary, they are the most frequently occurring taxa. Plants occurring along the perimeter of the barrier beach generally do not appear until late August, with flowering continuing through October. The most abundant taxa of the barrier beach shoreline are members of the genus Bidens.

As high water levels have eliminated most of the available marsh habitat, species characteristic of this habitat have survived in remnant embayment marshes. These areas are characterized by moist to very wet soil conditions. They are subject to encroachment and retreat of water owing to repeated fluctuations in water level of the estuary. Differences in the physical components of each remnant embayment marsh are reflected in their floral composition (Marshall and Stuckey, 1974). Abundant species of this habitat include Leersia oryzoides, Rumex verticillatus, Saururus cernuus, Scirpus fluviatilis, Sparganium eurycarpum and Typha latifolia.

The mudflat habitat is a result of fluctuating water levels within the estuary. Two major mudflats are present in the estuary. One mudflat exists along the former western shoreline of the stream, between Star Island and the Railroad. This area is marked in midsummer by Hibiscus palustris and Polygonum coccineum. The second mudflat is located west of the former stream bank at reference station E. This site is characterized by a near level slope which is frequently inundated. Species on this mudflat include Hibiscus palustris, Polygonum coccineum and Sparganium eurycarpum.

Terrestrial Habitats

Terrestrial habitats in the study area are covered by two vegetational types. The majority of the terrestrial habitats are covered with mixed hardwood forest, while smaller areas including the higher, drier portion of the barrier beach, the old field northwest

of the railroad trestle and the margins of United States route 6 and the railroad embankment are composed of herbaceous plants.

The three forest associations present on the upland portion of the study area are the Oak-Hickory association, the Maple association and the Sassafras-Oak-Hickory association. The Oak-Hickory association occupies the steep banks on the eastern and western sides of the estuary. This association is dominated by Quercus alba and Carya ovata, with associated species including Quercus palustris, Quercus rubra, Fraxinus americana, Viburnum prunifolium and Sassafras albidum. Herbaceous associates are most conspicuous during May and June. Examples are Trillium grandiflorum, Arisaema atrorubens, Viola spp. and Erythronium americanum. In July, Cimicifuga racemosa is in the open portions of the eastern bank Oak-Hickory forest. South of the Railroad, much of the eastern forest is currently inundated. Rumex verticillatus and Nuphar advena are dominants in the understory of this site. In the western bank Oak-Hickory forest, a small plantation of Pinus strobus thrives.

The Maple forest association occupies the small eastern bluff at the mouth of the estuary. Dominants at this site are Acer saccharinum and Acer rubrum. Associated woody species include Populus deltoides, Hammamelis virginica, Rhus glabra and Cornus florida.

A third forest association exists on Star Island. This woodland is primarily Sassafras albidum, with Quercus alba and Carya ovata comprising the major woody associates. Individuals of

these taxa here are in general younger than individuals in the woodlands of the eastern and western banks of the eastury, indicating more recent clearing. Herbaceous dominants of the spring flora are Trillium grandiflorum and Podophyllum peltatum. These two species are far more abundant on Star Island than in any other woodland in the study area.

While the perimeter of the barrier beach has been included with the wetland habitats, the higher, drier portion must be considered as a terrestrial area owing to its xeric nature. Only a few species thrive in this site, all herbaceous and all occur very infrequently. Among these are Salsola kali, Xanthium strummarium, Panicum capillare, Digitaria sanguinalis, Abutilon theophrasti and Hibiscus trionum.

The old field habitat is in an area north of the railroad track approximately 100 meters west of the trestle. This site differs from other old fields in the vicinity of Old Woman Creek in its vegetational composition. Here, principal species are Andropogon gerardi, Asclepias syriaca, Asclepias tuberosa, Aster spp., Lespedeza capitata, Lespedeza virginica, Silphium trifoliatum and Sorghastrum nutans. Other old fields in the vicinity of the study area are characterized by Ambrosia artemisiifolia, Ambrosia trifida, Polygonum pensylvanicum, Rhus glabra, Rhus typhina and Solidago spp.

The margins of United States route 6 and the railroad embankment represent yet another type of terrestrial habitat. Areas of this

type are commonly known as waste places owing to their continual subjection to disturbing influences, both physical and chemical. Many species occurring in these sites such as Chaenorrhinum minus, Epipactis latifolia, Hemerocallis fulva, Linaria vulgaris, Melilotus alba, Melilotus officinalis, Sedum telephium, and Saponaria officinalis are non-native "weedy" plants. These species are capable of surviving under disturbed conditions and frequently displace native vegetation.

Figure 2. Ground Cover Map of the Old Woman Creek Study Area

Key:

A - Forest Associations

A1 - Acer rubrum, Acer saccharinum, Cornus florida, Hammamelis virginica, Populus deltoides and Rhus glabra.

A2 - Quercus alba, Carya ovata, Fraxinus americana, Quercus palustris, Quercus rubra, Sassafras albidum and Viburnum prunifolium.

A3 - Sassafras albidum, Quercus alba, Carya ovata, Prunus pensylvanica, Catalpa bignonioides.

B - Old Fields

B1 - Andropogon gerardi, Asclepias syriaca, Asclepias tuberosa, Aster spp., Lespedeza virginica, Silphium trifoliatum, and Sorghastrum nutans.

B2 - Ambrosia artemisiifolia, Ambrosia trifida, Polygonum pensylvanicum, Rhus glabra, Rhus typhina and Solidago spp.

C - Aquatic and Wetland Vegetation

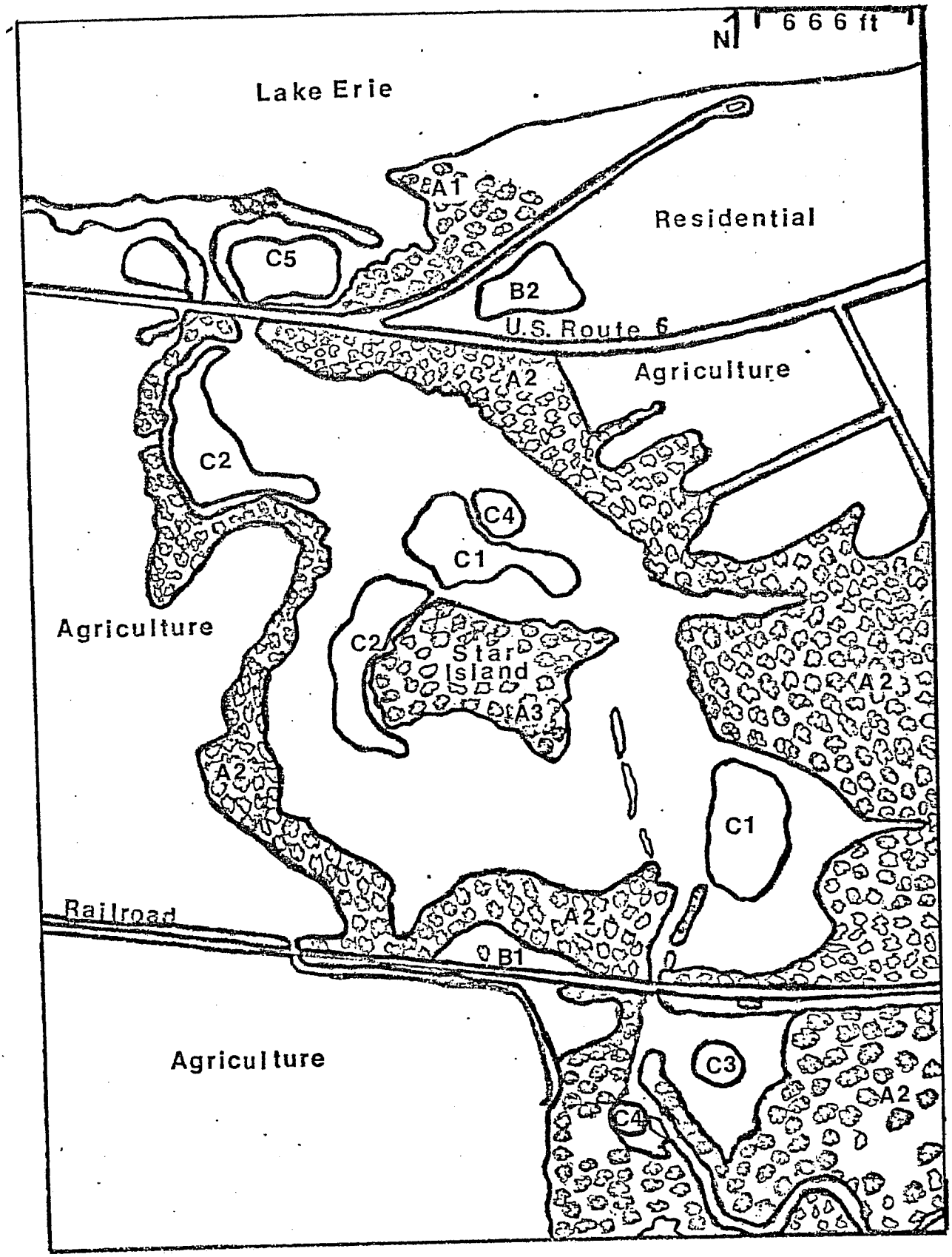
C1 - Nelumbo lutea

C2 - Peltandra virginica

C3 - Nuphar advena

C4 - Nymphaea tuberosa

C5 - Potamogeton pectinatus


N
6 6 6 ft
Lake Erie
A1
Residential
C5
B2
U.S. Route 6
A2
Agriculture
C2
C4
C1
Agriculture
C2
Star
Island
A3
A2
A2
C1
Railroad
A2
B1
Agriculture
C3
A2
C4

DISCUSSION

Hydrologic Characteristics

The low-lying floodplain at the mouth of Old Woman Creek, defined by its steep banks is herein referred to as a freshwater estuary. The use of the term estuary in a totally freshwater environment may seem inappropriate. However upon examining the physical parameters defining an estuary, it becomes apparent that each is applicable to the freshwater lake-stream environment with the exception of saline mixing. Coastal estuaries exist owing to the force of the rising tide reversing river currents (Fassett, 1928), while the verticle oscillation or seiche of the freshwater lake is responsible for the reversing of stream currents in the freshwater estuary.

Lake Erie is the thirteenth largest freshwater lake in the world and one of the shallowest. Because of its shallow average depth, Lake Erie exhibits changes in water level that seldom occur in other lakes of North America (Verber, 1958). Britt (1954) states that in observing these vertical oscillations for the first time, one might note the similarity between lake seiches and the tides of the Atlantic Ocean and the Gulf of Mexico. Langlois (1954) referred to flooded stream mouths, such as Old Woman Creek Estuary, as estuarial ponds, indicating the similarity of these areas to coastal estuaries. In spite of the similarity, changes in

the water level of Lake Erie result from different causes. Several explanations for these frequent vertical oscillations have been proposed. Krecker (1931) explains,

> "The possible causes of the seiche movement have been discussed by Forel ('95). He was of the opinion that the oscillations are set up by an area of exalted atmospheric pressure bearing down upon a particular region of a lake and pushing the water out to regions of low pressure. When exalted pressure passes, the water surges back, and, in the process of gaining equilibrium, exhibits oscillatory movement of a seiche."

This explanation may be true in part for Lake Erie seiches, however, Krecker further explains,

> "Forel's view undoubtedly explains some seiches, perhaps all seiches that occur on lakes protected from winds, but there is evidence (Krecker '29) that in wind-swept lakes, winds are an important agency in developing the seiche movement."

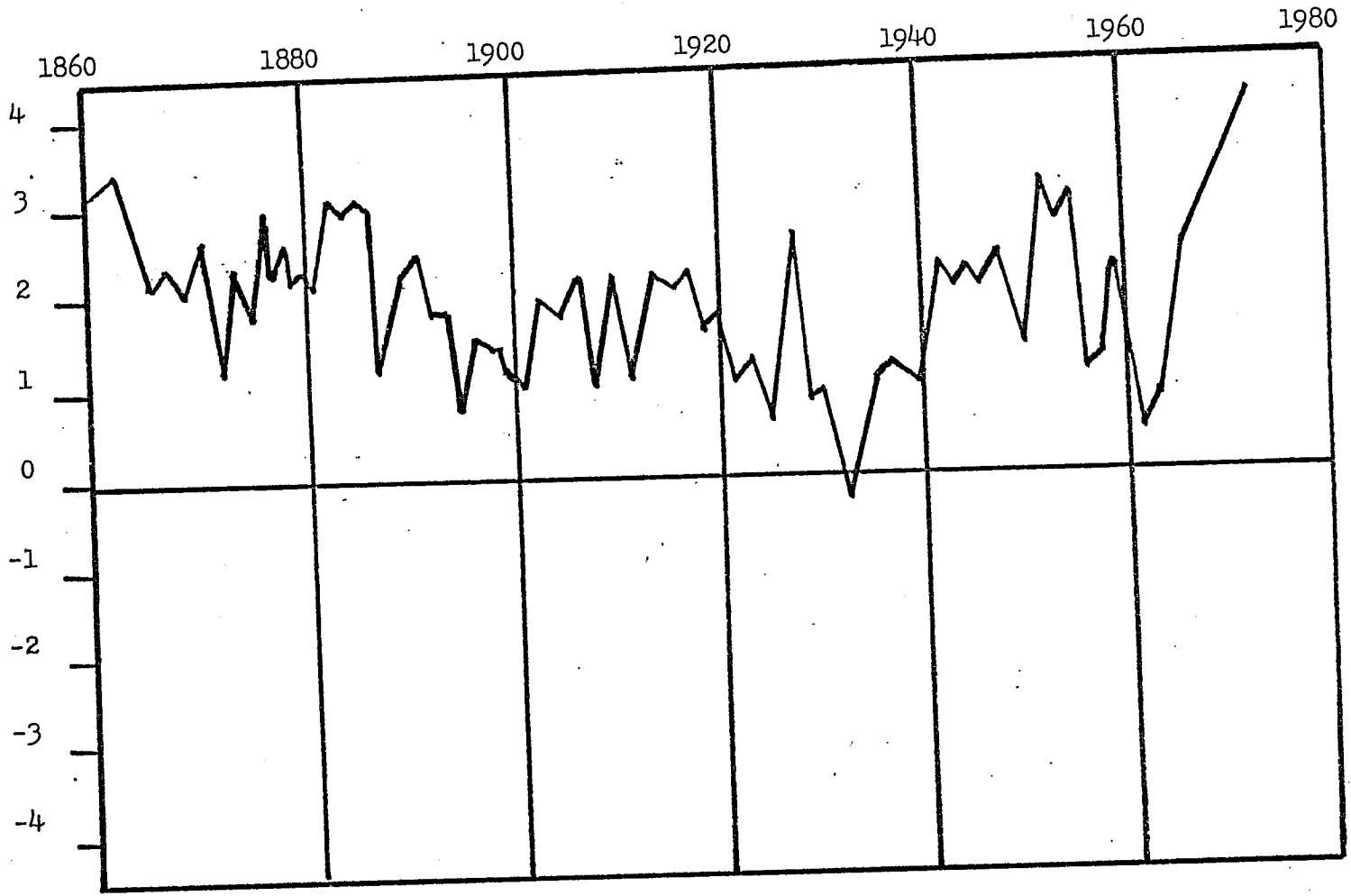
Certainly this latter alternative explains many of the extreme changes in the water level of Lake Erie. An example of this phenomenon occurred on 14 January, 1950 when 35 to 40 knot southwesterly winds in a 20 hour period, caused a drop in the water level at Put-in-Bay of over 1.5 meters (Britt, 1954). A similar situation occurred on 21 October, 1976 when strong southwesterly winds resulted in a dramatic lowering of water levels in Lake Erie's western basin. The drop in water level of western Lake Erie caused a related drop in the water level of the Old Woman Creek Estuary, which left a large portion of the previously inundated floodplain exposed. The subsequent back-surge of water resulted in an increase in the water level of the lake and estuary

greater than levels previous to the onset of the winds.

Lake seiche is an important factor in short period oscillations of the Lake and estuary water levels. The effect of wind blown seiche on the Old Woman Creek Estuary is readily observable, yet this type of seiche occurs less frequently than the seiche produced by barometeric differences. As weather fronts pass through the area every few days with their associated areas of high and low pressure (Miller, 1969), a consistent seiche is maintained. While many calculations have been made on the predominant seiche period, it is generally agreed that this period of oscillation is approximately of 14 hours duration (Verber, 1969). As Old Woman Creek Estuary lies on the south shore of the central lake basin, these short period oscillations are less pronounced than in areas lying in the southwestern or eastern basins. This situation is exemplified by Verber (1958) who reports an average seiche height of 15 centimeters at Sandusky, Ohio, while at Fairport, Ohio, 129 kilometers east of Sandusky, the average seiche height is only one to two inches.

In contrast to the short period oscillations are long period oscillations related to volumetric changes of Lake Erie (Figure 3) owing principally to precipitation, evaporation and run-off over the entire Great Lakes drainage area (Verber, 1960). These long period oscillations are extremely important in the establishment, loss and maintanence of the aquatic vegetation of the Old Woman Creek Estuary. Currently Lake Erie is exhibiting a prolonged high water level period, causing the inundation of the entire

Figure 3. Lake Erie Average Annual Levels



Levels shown in feet above or below the low water datum plane for Lake Erie (568.6 ft) (Hanna, 1970; U.S. Lake Survey, 1970-1976)

floodplain of the estuary. This inundation results in a reduction in the available marsh habitat and has left only a few remnant embayment marshes. These small sites provide a limited area for the persistence of the marsh vegetation, which during periods of low water levels thrived on the extensive floodplain. As no complete records exist on the composition of the flora during low water periods, it is impossible to state accurately the extent to which species composition in the estuary has been affected.

Estuaries are specialized environments, owing to frequent encroachment and retreat of water over shoreline and marsh areas. Fassett (1928) lists major factors influencing vegetation of salt marshes (estuaries) on the northeast coast of the United States. Among these are semidiurnal submergence, warm water, copius deposits of mud and varying salinity. These factors are also operative in the Old Woman Creek Estuary. Fassett states that some species become almost unrecognizable under these conditions. He attributes these aberrant growth forms primarily to the deposition of mud on leaf and stem surfaces in conjunction with the force of rushing tidal water which causes typically erect plants to become prostrate. This reaction to estuarine conditions was not observed in the Old Woman Creek Estuary, even though some species which Fassett discusses are present in the flora of the estuary. The absence of such plant reactions to estuarine conditions in the Old Woman Creek Estuary is probably a function of the limited degree to which short period oscillations inundate the estuary's vegetation. Should water

level fluctuation be more pronounced, it is likely that such plant reactions would occur, as Old Woman Creek carries a heavy silt load.

Turbidity

Strong correlations between the extent of vegetation and water depth, water depth and turbidity, and turbidity and amount of vegetation have been reported by Robel (1961). He observed that deeper waters contain less suspended matter and support larger crops of aquatic vegetation. In the Old Woman Creek Estuary, turbidity, expressed as the depth to which a secchi disc remains visible, is seldom greater than 50 cm. The high turbidity levels result from several related factors, and have a pronounced effect on aquatic vegetation. The initial cause of high turbidity levels is erosion from the agricultural land in the stream's drainage area. This condition is further enhanced by wind propagated wave action in the shallow open water areas of the estuary, and perhaps more so by the feeding habits of the numerous resident and anadromous carp (Cyprinus carpio).

The majority of the open water habitat in the Old Woman Creek Estuary is very shallow (20 to 100 centimeters) and subject to wind and wave action. These areas are quite turbid and are very limited in both species diversity and abundance of aquatic plants. As a noteworthy example of adaptability to turbid conditions, Langlois (1954) cites Potamogeton pectinatus, which is the only submersed aquatic plant thriving in the open water habitats of the

estuary. However, in shallow upstream bays, where trees act as wind breaks, turbidity is less pronounced. Ceratophyllum demersum occurs here.

The feeding and spawning habits of carp are leading contributors to high turbidity levels (Pieters, 1901). In addition, carp may affect vegetation by uprooting plants while feeding or by their actual consumption. King and Hunt (1967) believe that in submersed rooted aquatic plants uprooting is probably most important, with some food consumption occurring. From observational evidence, this phenomenon appears to be occurring in the Old Woman Creek Estuary. The destructive effects of carp on vegetation are not limited to submersed plants, but are equally deleterious to emersed rooted plants. Browsing and spawning carp loosen the substrate from the roots of plants, causing them to be uprooted. The reason for the lack of cattails and sedges in areas of the estuary which appear suitable for their growth, such as at referrence station E, may involve the activities of carp.

Analysis of the Geographical Relationships of the Indigenous Floristic Component

The geographical affinity of each indigenous species, as listed in the appendix, was based upon distributional data in Fernald (1950) and Stuckey and Duncan's unpublished Flora of the Erie Islands: Its Origin, History, and Change. As the Old Woman Creek area was glaciated by the Wisconsin ice sheet, all species now present must have entered the area after the retreat of the glacier.

Because the ice sheet lay to the north, indigenous plants must have entered the area from the south, east, or west. Therefore, the indigenous flora of the Old Woman Creek Estuary and contiguous uplands is segregated into the groups as explained in Table 1. In this classification, members of the indigenous widespread and widespread in eastern United States elements exhibit wide ecological tolerance, hence they are capable of thriving throughout their ranges in numerous habitats and in general are more common than species with restricted geographical affinities. Members of the southern, eastern and western floristic elements have narrow ecological tolerance, and are in general less common in our flora. The presence or absence of species of restricted geographical affinities may be used as an indicator of environmental quailty, based on their inability to thrive under disturbed conditions.

The greatest percentage of the indigenous flora is of the widespread in the eastern United States element (107 of 203 or approximately 53 percent, Table 1). These taxa tend to be most prevalent in the study area (Abundant, Common). Those taxa of the widespread element comprise another substantial portion of the indigenous flora (58 of 203 or approximately 28 percent). Taxa of the widespread element also appear more prevalent throughout the study area. Only 14 percent of the flora is shown to represent species of restricted distributions. Eastern, southern, and western species comprise only 4 percent, 6 percent, and 4 percent respectively. Taxa of these restricted ranges are in general less common in the study area (Table 2), with two notable exceptions. Both Peltandra

virginica, of eastern affinity, and Nelumbo lutea, of southern affinity, are abundant in the estuary. These species thrive on the inundated floodplain of the estuary, and therefore currently have ample habitat. Upon a lowering of the water level sufficient to expose the floodplain and the encroachment of wetland species, one might expect a reduction in the abundance of Peltandra virginica and Nelumbo lutea. This situation may be exemplory of the relationship between fluctuating water-levels and fluctuating species abundance. However, the opportunity to test this hypothesis will not become available until a major reduction in lake elevation occurs.

Table 1

Analytical Table of Geographical Affinities

Floristic Element	Number of Species	Approximate Percent of the Indigenous Flora*	Approximate Percent of Total Flora
Indigenous			
Widespread	58	28	21
Widespread in Eastern United States	107	53	39
Eastern	10	5	4
Southern	16	8	6
Western	11	6	4
Non-indigenous	71	--	26
Totals	273	100	100

*Based on a total of 202 indigenous species.

Explanation of Geographical Categories:

Widespread: occurring throughout most of North America or continental United States.

Widespread in Eastern United States: occurring from The Great Plains or the Mississippi River eastward throughout eastern United States and eastern Canada.

Eastern: occurring on the Atlantic Coastal Plain or in the Southern Appalachian Mountains and ranging inland north of the glacial boundary into the Great Lakes Region sometimes northwest to Minnesota, the Dakotas, and/or Manitoba.

Western: occurring in the Rocky Mountains or other parts of western North America and ranging north of the glacial

Table 1 continued

boundary through the northern plains states, the Great Lakes Region, and sometimes as far east as New England.

Southern: occurring in southern United States, the Ozarks, or the unglaciated Mississippi River basin sometimes eastward to the southern Atlantic Coast, and ranging north and northeast of the glacial boundary; with many reaching their northern limits in the southern Great Lakes Region.

Table 2

Abundance of Species of Limited Geographical Affinity.

Species	Abundance in the Old Woman Creek Estuary
Eastern	
Bidens connata	Occasional
Gentiana andrewsii	Rare
Geum laciniatum	Occasional
Hibiscus palustris	Common
Osmunda cinnamomea	Occasional
Peltandra virginica	Abundant
Potentilla canadensis	Occasional
Rosa blanda	Rare
Stachys tenuifolia	Occasional
Typha angustifolia	Rare
Southern	
Carex frankii	Rare
Cinna arundinacea	Rare
Cornus drummondii	Common
Echinocystis lobata	Common
Eclipta alba	Rare
Gaura biennis	Occasional
Nelumbo lutea	Abundant
Phytolacca americana	Occasional
Polanisia dodecandra	Rare
Potamogeton nodosus	Rare
Quercus palustris	Common
Rumex verticillatus	Common
Saururus cernuus	Rare
Strophostyles helvola	Common
Vernonia altissima	Occasional
Viola striata	Occasional
Western	
Astragalus canadensis	Rare
Calamagrostis canadensis	Occasional
Cyperus engelmannii	Occasional
Desmodium laevigatum	Common
Iris versicolor	Common
Lycopus uniflorus	Occasional
Rorippa palustris var. hispida	Common

Table 2 continued

Species	Abundance in the Old Woman Creek Estuary
Rumex orbiculatus	Rare
Scirpus fluviatilis	Common
Scutellaria epilobiifolia	Common
Spirea alba	Rare

Analysis of the Non-Indigenous Floristic Component

Species foreign to the Great Lakes region are considered non-indigenous. They may be adventive, naturalized, or deliberately introduced. These taxa are important in assessing the degree to which man's activities have altered the natural state of the environment. A significant portion of the total flora is composed of non-indigenous species (71 of 274, or approximately 26 percent). This indicates a displacement of native species, owing to habitat disruption or exclusion. Most of the non-indigenous taxa included in the flora of the Old Woman Creek area were present in Erie County prior to 1899 (Table 3). These taxa are well established in the disturbed sites of the study area, as well as the whole of Erie County. Those species currently occurring in the study area which were not reported by Moseley (1899) are mostly rare in occurrence, perhaps indicating a restriction of available disturbed habitat related to the occupation of these sites by other non-indigenous species. Non-indigenous species which are known to have become established in Erie County since 1899 include:

Aegilops cylindrica
Allium sativum
Antirrhinum majus
Brassica campestris
Brassica hirta
Bromus japonicus
Butomus umbellatus
Mentha x cardiaca
Ribes sativum
Senecio glabellus
Urtica dioica
Catalpa bignonioides
Cycloloma atriplicifolium
Epipactis latifolia
Galinsoga parviflora
Hieracium venosum
Lonicera japonica
Lycopus europaeus
Ranunculus repens
Salsola kali
Setaria faberi

Table 3

Comparison of Non-Indigenous Species and their Abundance as Reported by Moseley (1899) for Erie County and Those Occurring in Old Woman Creek Study Area, 1976

Non-Indigenous Species	Abundance in Erie County Prior to 1899, as recorded by Moseley (1899)	Abundance in the Old Woman Creek Estuary, 1976
Abutilon theophrasti	Common	Rare
Achillea millefolium	Abundant	Occasional
Aegilops cylindrica	Not Reported	Rare
Alliaria officinalis	Present	Abundant
Allium sativum	Not Reported	Occasional
Amaranthus albus	Common	Rare
Amaranthus retroflexus	Common	Occasional
Antirrhinum majus	Not Reported	Rare
Arctium minus	Present	Occasional
Asparagus officinalis	Present	Occasional
Barbarea vulgaris	Frequent	Rare
Brassica campestris	Not Reported	Occasional
Brassica hirta	Not Reported	Occasional
Bromus japonicus	Not Reported	Rare
Butomus umbellatus	Not Reported	Rare
Catalpa bignonioides	Not Reported	Rare
Chenopodium album	Common	Rare
Chaenorrhinum minus	Present	Occasional
Chichorium intybus	Common	Occasional
Cirsium arvense	Frequent	Occasional
Cycloloma atriplicifolium	Not Reported	Rare
Daucus carota	Infrequent	Occasional
Digitaria sanguinalis	Abundant	Rare
Echinochloa crusgalli	Abundant	Rare
Epipactis latifolia	Not Reported	Rare
Galinsoga parviflora	Not Reported	Rare
Hemerocallis fulva	Infrequent	Rare
Helianthus tuberosa	Frequent	Occasional
Hesperis matronalis	Present	Occasional
Hibiscus trionum	Frequent	Rare
Hieracium venosum	Not Reported	Occasional
Hypericum perforatum	Frequent	Occasional

Table 3 continued

Non-Indigenous Species	Abundance in Erie County Prior to 1899, as recorded by Moseley (1899)	Abundance in the Old Woman Creek Estuary, 1976
Lamium purpureum	Present	Common
Linaria vulgaris	Common	Rare
Lonicera japonica	Not Reported	Occasional
Lycopus europaeus	Not Reported	Rare
Lysimachia nummularia	Frequent	Abundant
Melilotus alba	Abundant	Occasional
Melilotus officinalis	Infrequent	Occasional
Mentha x cardiaca	Not Reported	Rare
Mirabilis nyctaginea	Present	Rare
Nepeta cataria	Common	Occasional
Phalaris arundinacea	Infrequent	Abundant
Phleum pratense	Abundant	Occasional
Pinus strobus	Present	Rare
Plantago major	Common	Rare
Polygonum convolvulus	Common	Rare
Polygonum persicaria	Abundant	Occasional
Portulaca oleracea	Abundant	Rare
Ranunculus repens	Not Reported	Common
Ribes sativum	Not Reported	Occasional
Rosa multiflora	Present	Occasional
Rumex crispus	Abundant	Occasional
Salsola kali	Not Reported	Rare
Saponaria officinalis	Frequent	Occasional
Sedum telephium	Present	Rare
Senecio glabellus	Not Reported	Occasional
Setaria glauca	Abundant	Occasional
Setaria faberi	Not Reported	Common
Solanum dulcamara	Frequent	Common
Solanum nigrum	Common	Occasional
Taraxicum officinale	Abundant	Abundant
Urtica dioica	Not Reported	Occasional
Valerianella radiata	Scarce	Occasional
Xanthium strumarium	Common	Occasional

The high percentage of non-indigenous species is significant as an indicator of the degree to which the area has been changed by man's activities. This 26 percent of the flora is consistent with percentages for much larger areas where there has been extensive disturbance. For example, Fernald (1950) reports 1,098 non-indigenous species of the total 5,523 species (19 percent) in the flora of the central and northeastern United States and adjacent Canada (Table 4). Throughout much of the area referred to by Fernald, intense agriculture and urbanization prevail. Within this area Ohio is one of the states that is extensively disturbed by agriculture and urbanization, perhaps even more than any other state in the northeastern and central United States. It therefore follows that of Ohio's 2,518 species, 599 (24 percent) are non-indigenous (Table 4).

Local disturbed areas within Ohio, such as the Erie Islands, exhibit even higher percentages of non-indigenous species (276 of 847, or 33 percent). In a two-acre marsh at Perry's Victory Monument on South Bass Island, Stuckey (1975) reports 46 non-indigenous species of 128 species in the total flora (36 percent). He explains that in this marsh, formerly a lawn community, "the new marsh community. . .is maintained by the natural disturbance of the fluctuating water levels of Lake Erie, whereas the former lawn community is one associated and maintained by man as an artificially disturbed plant community." Within the Old Woman Creek study area, both man-disturbed and naturally disturbed habitats are present

Table 4

Comparison of Species Composition in Variously Disturbed Areas

Area	Number of Native Species	Number of Non-Indigenous Species	Number of Species in the Total Flora	Approximate percentage of Non-Indigenous Species in the Total Flora	Size of Area
Old Woman Creek and adjacent uplands, Erie County, Ohio.	202	71	273	26%	1,000 acres
A marsh at Perry's Victory Monument, South Bass Island, Ottawa County, Ohio (Stuckey, 1975).	82	46	128	36%	2 acres
Erie Islands, Erie and Ottawa Counties, Ohio (Stuckey and Duncan, unpublished).	571	276	847	33%	15,801 acres
Fort Hill State Memorial, Highland County, Ohio (Braun, 1969).	585	65	650	10%	1,200 acres
Ohio (Weishaupt, 1971).	1,919	599	2,518	24%	41,222 $mi.^2$
Central and Northeastern United States and Adjacent Canada (Fernald, 1950).	4,425	1,098	5,523	19%	6,455,786 $mi.^2$

and presumably contribute to the maintenance of non-indigenous plant communities. In contrast to these highly disturbed areas in Ohio are some less disturbed areas, such as the Fort Hill State Memorial, Highland County. Braun (1969) states "Disturbed areas suitable for introduced weeds are few and mostly confined to the southern margin of the park," hence only 65 of the 650 species occurring at Fort Hill are non-indigenous.

The introduction of these foreign species to the Old Woman Creek area may have proceeded along several "corridors" of migration. As most of the non-indigenous taxa are of Eurasian origin, it follows that cross-oceanic trade or travel may be implicated in their introduction to North America. This would account for the introduction of foreign taxa at the major North American sea ports. One must then account for their migration inland.

In the Old Woman Creek area, two modes of introduction appear feasible. First, it must be noted that many of these foreign taxa are classified as "weeds", in part because of their ability to thrive in disturbed habitats. With this in mind, one must locate disturbed habitats which are contiguous, or nearly so, with coastal areas. Three such disturbed areas cross Old Woman Creek. The lake front is a naturally disturbed site, owing to wind and wave action. Ship traffic in the Great Lakes has been active for many years. Should a propagule be carried from a foreign port and deposited along a Great Lake shoreline, a continuous disturbed habitat would be encountered, thus facilitating the

migration of the taxon. Butomus umbellatus, a non-indigenous species introduced from Europe, thrives along the lake shore at the mouth of Old Woman Creek. The actual point of introduction for Butomus umbellatus remains somewhat in question (Stuckey, 1968). However, it is generally accepted that this species has migrated into the southern Lake Erie region from its original point of introduction (Core, 1941; Stuckey, 1968). The migration inland of Butomus umbellatus serves to illustrate the feasibility of the lake shore corridor of migration. Examples of other non-indigenous species which have probably arrived in the Old Woman Creek area via the lake shore corridor include:

Abutilon theophrasti
Barbarea vulgaris
Brassica hirta
Chenopodium albidum
Cycloloma atriplicifolium
Echinochloa crusgalli
Galinsoga parviflora
Hemerocallis fulva
Hibiscus trionum
Lycopus europaeus
Portulaca oleracea
Salsola kali
Setaria glauca
Xanthium strumarium

Two man-disturbed corridors, the railroad and United States route 6, cross Old Woman Creek. This type of corridor undergoes frequent disruption by man by the application of road salts and herbicides, as well as frequent physical modification. One example of the migration of a foreign species along this corridor type is evident in the occurrence of Epipactis latifolia, along the railroad near Old Woman Creek. This European orchid was first reported in New York State on 2 August 1879, near Syracuse. Since its introduction to North America, it has become established in New York State, as a roadside weed (House, 1933). It was first

reported in Ohio in 1958 and again in 1959, from Summit County (Braun, 1967). The occurrence of one individual in close proximity to the railroad may indicate the westward migration of this species via the railroad-highway corridor. Other non-indigenous species occurring exclusively in the railroad-highway corridor include:

Antirrhinum majus	Melilotus alba
Asparagus officinalis	Melilotus officinalis
Chaenorrhinum minus	Nepeta cataria
Chichorium intybus	Saponaria officinalis
Linaria vulgaris	Sedum telephium

Further confirmation of the feasibility of the corridor concept may be found in Figure 4, which clearly shows the aggregation of non-indigenous species along the three migration corridors of Old Woman Creek.

Figure 4. Occurrence and Number of Non-Indigenous Species in the Old Woman Creek Study Area

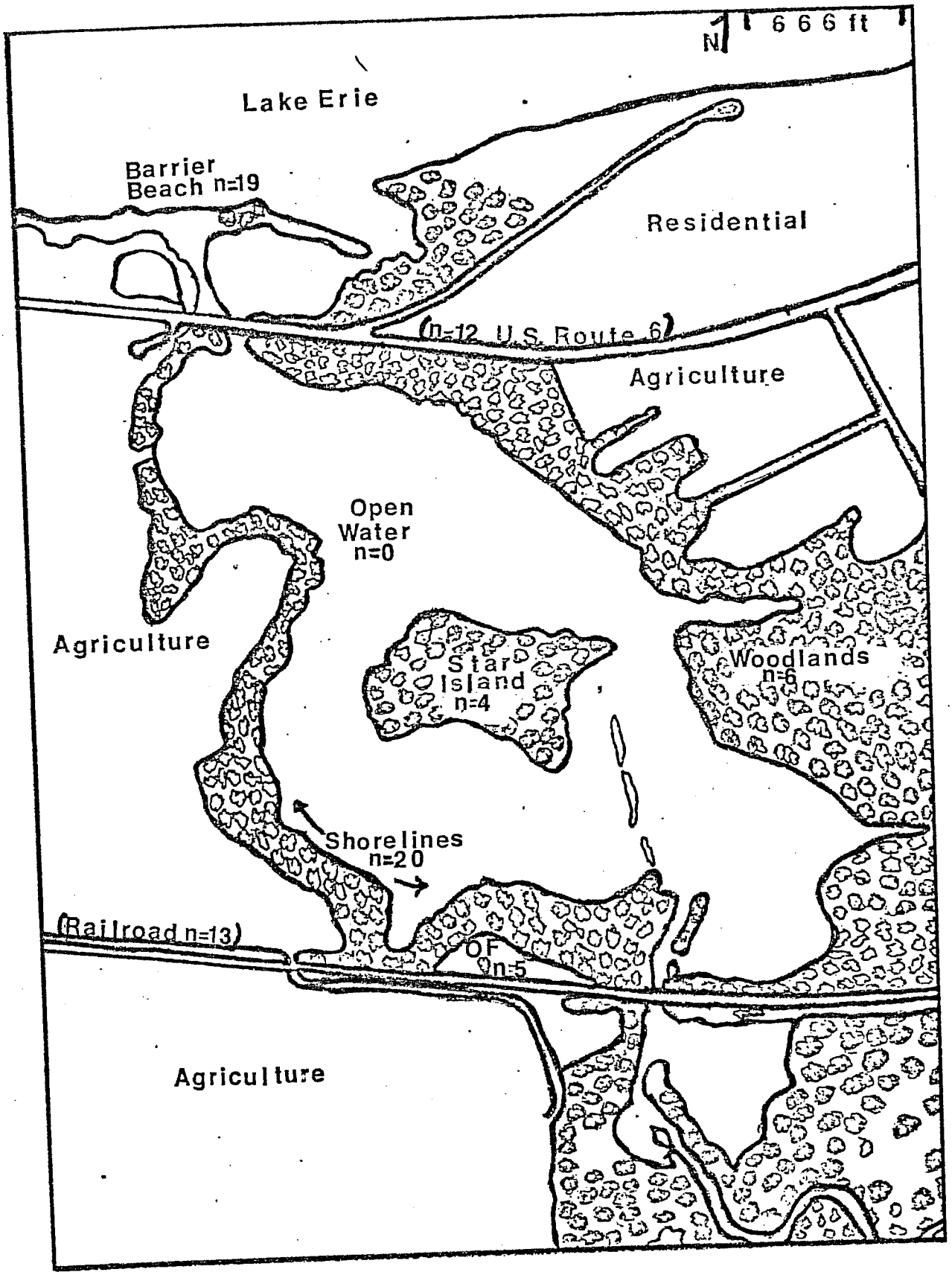
Key:

"n" equals the number of non-indigenous species occurring in a site

"OF"..... Old Field

Summary:

	Number of Non-Indigenous Species
Barrier Beach	19
Old Field	5
Open Water	0
Railroad	13
Shoreline	20
Star Island	4
United States Route 6	12
Woodlands	6


N
1 6 6 6 ft
Lake Erie
Barrier Beach n=19
Residential
(n=12 U.S. Route 6)
Agriculture
Open Water n=0
Agriculture
Star Island n=4
Woodlands n=6
Shorelines n=20
(Railroad n=13)
OF n=5
Agriculture

Analysis of Aquatic Flora and Comparison to Other Wetland Areas of Western Lake Erie

Presently, the aquatic and wetland flora of the Old Woman Creek Estuary is depauperate in comparison with other aquatic and wetland areas in the southern Lake Erie region. Tables 5 and 6, taken as a unit, comprise a list of 293 aquatic and wetland plants occurring in the southwestern Lake Erie watershed. The taxa were determined to be a regional standard for the herbaceous aquatic plants developed from a list of aquatic and wetland plants of northwestern Ohio (Stuckey, 1972). As detailed floristic studies of East Harbor State Park and Winous Point Shooting Club have been completed (Moore, 1973; Lowden, 1967), these areas along with the Old Woman Creek Estuary were chosen for comparison against this regional aquatic flora standard.

Of the 47 species occurring in the open water habitat within the region, only 8 (17%) occur in the Old Woman Creek Estuary whereas 19 of the 47 species (40%) each occur at East Harbor State Park and Winous Point Shooting Club (Table 5). This conspicuous lack of species diversity in the open water habitat of the Old Woman Creek Estuary is due principally to the absence of submersed species of the genera Elodea, Myriophyllum, Najas and Potamogeton (Table 5). As previously discussed, high turbidity is believed to be the chief factor limiting the establishment of these taxa.

Species diversity in the marsh and shoreline habitats is similarly low in the estuary. Of the 246 species included in the

regional standard, only 82 (33%) occur in the Old Woman Creek Estuary, whereas 130 (53%) occur at East Harbor State Park and 115 (47%) occur at Winous Point Shooting Club (Table 6). Genera which are poorly represented in the aquatic and wetland flora of the Old Woman Creek Estuary, yet well represented at both East Harbor State Park and Winous Point Shooting Club are Carex, Eleocharis, Juncus and Scirpus (Table 6). Of the 64 species included in the regional standard for these four genera, only 7 (11%) occur in the Old Woman Creek Estuary, while 34 (53%) occur at East Harbor State Park and 25 (39%) occur at Winous Point Shooting Club. These genera, commonly referred to as sedges and rushes, are principal components of the region's well-developed marshes, where they grow on extensive mudflats or in shallow water. In analyzing the conditions contributing to the limited species composition on marsh and shoreline vegetation, it is appropriate to examine the physical distinctions of the Old Woman Creek Estuary and East Harbor State Park and Winous Point Shooting Club. The most striking physical distinction of the Old Woman Creek Estuary is its steep banks which limit the extent to which mudflats and shallow water prevail with changing water levels. In both East Harbor State Park and Winous Point Shooting Club, broad expansive low-level flatland and the topography of gentle slopes allow for the encroachment of the sedges, rushes and other wetland plants onto formerly dry areas with the onset of high water levels. The near level topography of East Harbor State Park also allows for the

establishment of "micro-marshes," which Moore (1973) describes as areas which collect water during years of high precipitation. This condition, in effect, allows for the short-term establishment of new marshes. In the Old Woman Creek Estuary, however, as water levels rise to the point of abutment with the steep banks, the habitat for aquatic and wetland plants is reduced to a few remnant embayments with only a few species. Unlike the extensive marsh which from time to time has occupied the floodplain of Old Woman Creek in the past, these remnant embayment marshes are subject to considerable shading from nearby trees. In marshes with extensive shading, such as reference station C (Figure 5), species diversity is quite low (33 of 82 species or 40%). In comparison, reference station B (Figure 6) receives nearly full sunlight and is composed of many wetland species (64 of 92 or 76%) (Marshall and Stuckey, 1974). In summary, two factors may be implicated in the limitation of species diversity in the wetland habitats in the Old Woman Creek Estuary. Most important is the limitation of marsh expansion by the steep well-drained banks defining the floodplain. Secondarily, limited incident light appears to restrict the establishment of wetland species in remnant embayment marshes.

It must be realized that the current depauperate state of the aquatic and wetland flora does not imply that this condition existed in the past nor does it imply that limited species diversity will persist in the future. Old Woman Creek Estuary is a dynamic environment and in the event of substantially lower water levels,

(Figure 3) the inundated floodplain should revert to larger marshes and mudflats. This situation will dramatically increase the available marsh area not shaded by trees and may allow for the establishment of species currently not occurring in the estuary. Dormant propagules of these species may already be in the estuary but as past floristic records are lacking, one may only speculate in this regard.

Figure 5. Reference Station B looking northeast. Old Woman Creek in foreground; near center background, reference station B; far background, United States Route 6.

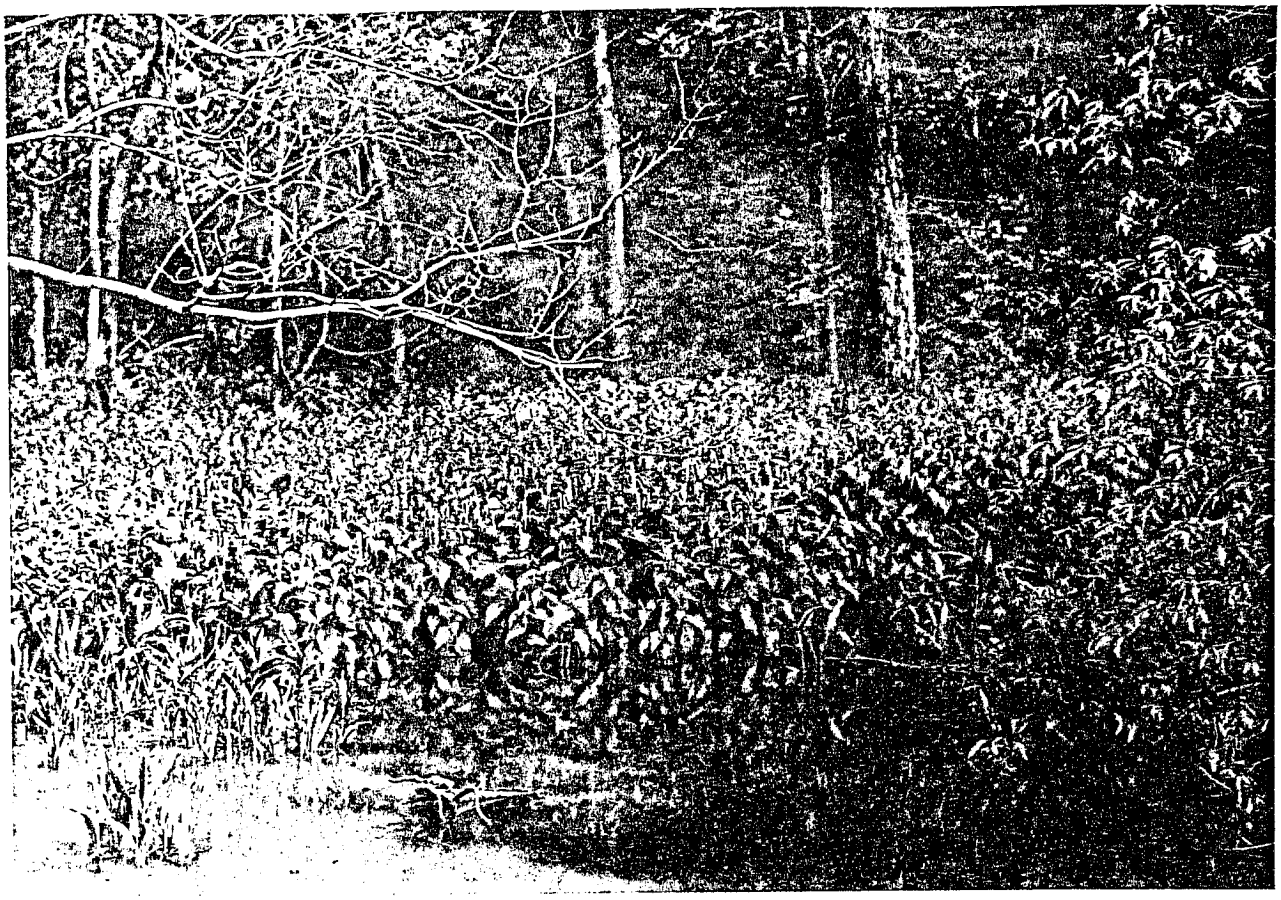


Figure 6. Reference Station C looking southeast. Saururus cernuus and Rumex verticillatus in foregound; background, oak-hickory forest.

Table 5

Species Composition of Aquatic Plants in Three Lake Erie Marshes as Compared to a Total of 45 Species Known from the Marshes of Southwestern Lake Erie (regional standard)

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Azolla caroliniana	-	-	X
Brasenia schreberi	-	-	-
Ceratophyllum demersum	X	X	X
Ceratophyllum echinatum	-	-	-
Elodea canadensis	-	X	-
Elodea nuttalii	-	-	X
Heteranthera dubia	-	X	X
Lemna minor	X	X	X
Lemna trisulca	-	X	X
Myriophyllum exalbescens	X	X	-
Najas flexilis	-	X	-
Najas gracillima	-	-	-
Najas guadalupensis	-	-	-
Najas marina	-	-	-
Najas minor	-	X	X
Nelumbo lutea	X	X	X
Nuphar advena	X	X	X
Nuphar variegatum	-	X	X
Nyphaea tuberosa	X	X	X
Polygonum amphibium	-	-	-
Potamogeton amplifolius	-	-	-
Potamogeton berchtoldii	-	-	-
Potamogeton crispus	-	-	X
Potamogeton filiformis	-	-	-
Potamogeton foliosus	-	X	X
Potamogeton friesii	-	-	-
Potamogeton gramineus	-	-	-
Potamogeton illinoensis	-	-	-
Potamogeton natans	-	-	-
Potamogeton nodosus	X	-	X

Table 5 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Potamogeton pectinatus	X	X	X
Potamogeton perfoliatus	-	-	-
Potamogeton praelongus	-	-	-
Potamogeton pusillus	-	-	-
Potamogeton richardsonii	-	-	-
Potamogeton robbinsonii	-	-	-
Potamogeton strictifolius	-	-	-
Potamogeton zosteriformis	-	X	-
Prosperinaca palustris	-	-	-
Spirodela polyrhiza	X	X	X
Utricularia gibba	-	-	-
Utricularia resupinata	-	-	-
Utricularia vulgaris	-	X	X
Vallisneria americana	-	X	-
Wolffia columbiana	-	X	X
Wolffia punctata	-	-	-
Zannichellia palustris	-	-	-

Table 6

Species Composition of Wetland Plants in Three Lake Erie Marshes as compared to a Total of 246 Species Known from the Marshes of South-Western Lake Erie (regional standard)

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Acalypha rhomboidea	X	X	X
Acorus calamus	X	-	-
Alisma plantago-aquatica	-	X	X
Ammania coccinea	-	-	X
Amphicarpa bracteata	-	-	X
Amoracea aquatica	-	-	-
Armoracea rusticana	-	-	-
Asclepias incarnata	X	X	X
Bidens bipinnata	-	X	-
Bidens cernuus	X	X	X
Bidens comosus	-	X	X
Bidens connatus	X	X	-
Bidens coronatus	-	X	-
Bidens frondosus	X	X	X
Bidens heterodoxus	-	X	-
Bidens vulgatus	-	X	-
Boehmeria cylindrica	X	X	X
Boltonia asteroides	-	X	X
Butomus umbellatus	X	X	X
Calamagrostis canadensis	X	X	X
Callitriche heterophylla	-	-	-
Campanula aparinoides	-	X	-
Cardamine bulbosa	-	X	-
Cardamine pensylvanica	X	X	X
Carex amphibola	-	-	X
Carex annectans	-	X	-
Carex aquatilis	-	-	-
Carex atherodes	-	-	X
Carex blanda	-	X	-
Carex buxbaumii	-	-	-

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Carex comosa	-	X	X
Carex crawei	-	-	-
Carex cristatella	-	-	X
Carex davisii	-	X	-
Carex eburnea	-	-	-
Carex flava	-	-	-
Carex frankii	X	X	X
Carex garberi	-	X	-
Carex granularis	-	X	X
Carex grayii	-	-	X
Carex haydenii	-	X	-
Carex hystricina	-	X	-
Carex lacustris	-	X	X
Carex laevivaginata	-	X	-
Carex lanuginosa	-	X	X
Carex lupulina	-	X	-
Carex lurida	-	-	-
Carex muhlenbergii	-	-	X
Carex muskingumensis	-	X	-
Carex pauciflora	-	-	-
Carex rosea	-	-	X
Carex stipata	-	X	X
Carex stricta	-	-	-
Carex viridula	-	-	-
Carex vulpinoidea	X	X	X
Chelone glabra	X	-	-
Cicuta bulbifera	-	-	X
Cicuta maculata	X	-	X
Cyperus diandrus	-	X	X
Cyperus engelmanii	X	X	-
Cyperus erythrorhizos	-	X	X
Cyperus esculentus	X	X	X
Cyperus ferruginescens	X	X	X
Cyperus flavescens	-	-	-
Cyperus inflexus	-	-	-

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Cyperus rivularis	X	X	X
Cyperus strigosus	X	X	X
Decodon verticillatus	X	X	X
Dulichium arundinaceum	-	-	-
Echinochloa crusgalli	X	X	X
Echinochloa pungens	X	X	-
Echinochloa walteri	X	X	X
Echinocystis lobata	X	X	X
Eclipta alba	X	-	X
Eleocharis acicularis	-	-	X
Eleocharis compressa	-	-	-
Eleocharis elliptica	-	-	-
Eleocharis erythropoda	-	X	X
Eleocharis geniculata	-	-	-
Eleocharis intermedia	-	-	-
Eleocharis obtusa	-	X	X
Eleocharis olivacea	-	X	X
Eleocharis ovata	-	X	-
Eleocharis palustris	-	-	-
Eleocharis rostellata	-	-	-
Eleocharis smallii	-	X	X
Epilobium glandulosum	X	-	X
Epilobium hirsutum	-	X	-
Eragrostis hypnoides	-	X	-
Erechtites hieracifolia	-	X	X
Eupatorium maculatum	-	-	X
Eupatorium perfoliatum	X	-	X
Euphorbia humistrata	-	-	-
Fibristylis autmnalis	-	-	-
Gerardia purpurea	-	X	-
Gerardia tenuifolia	-	X	-
Glyceria septentrionalis	-	-	-
Glyceria striata	X	X	X
Gratiola neglecta	-	X	-
Helenium autumnale	-	-	-

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Hibiscus militaris	-	-	-
Hibiscus palustris	X	X	X
Houstonia nigricans	-	X	-
Hypericum boreale	-	-	-
Hypericum kalmianum	-	-	-
Hypericum mutilum	-	-	-
Hypericum perforatum	X	-	-
Hypericum punctatum	X	-	-
Hypericum virginicum	-	-	-
Impatiens capensis	X	X	X
Iris brevicaulis	-	-	-
Iris pseudacorus	-	-	-
Iris versicolor	X	X	-
Iris virginica	-	-	X
Juncus alpinus	-	X	-
Juncus articulatus	-	X	-
Juncus balticus	-	X	-
Juncus canadensis	-	-	-
Juncus dudleyi	-	X	X
Juncus effusus	X	X	-
Juncus nodosus	-	X	-
Juncus torreyi	-	X	X
Justicia americana	-	-	-
Leersia oryzoides	X	X	X
Leucospora multifida	-	-	-
Lindernia dubia	X	X	X
Lippia lanceolata	-	X	X
Lobelia cardinalis	-	-	-
Lobelia kalmii	-	X	-
Lobelia syphilitica	X	X	-
Lophotocarpus calycinus	-	X	X
Ludwigia alternifolia	-	-	-
Ludwigia palustris	X	X	X
Ludwigia polycarpa	-	-	-
Lucapus americanus	X	-	X

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Lycopus asper	-	X	-
Lycopus europaeus	X	X	-
Lycopus rubellus	-	X	-
Lycopus x sherardi	X	-	-
Lycopus uniflorus	X	-	X
Lysimachia ciliata	X	-	X
Lysimachia nummularia	X	X	X
Lysimachia quadriflora	X	X	-
Lysimachia terrestris	-	-	-
Lysimachia thyrsiflora	-	X	X
Lythrum dacotanum	-	X	-
Lythrum salicaria	-	X	X
Megalodonta beckii	-	X	-
Mentha arvensis	X	X	X
Mentha x cardiaca	X	-	-
Mentha gentilis	-	-	-
Mentha piperita	-	-	-
Mentha spicata	-	-	-
Mimulus ringens	X	-	X
Myosotis scorpiodes	-	-	-
Nasturtium officinale	-	-	-
Parnassia glauca	-	-	-
Peltandra virginica	X	-	-
Penthorum sedoides	X	X	X
Phalaris arundinacea	X	X	X
Phalaris canariensis	-	-	-
Phragmites australis	-	X	X
Physostegia virginiana	-	X	X
Pilea fontana	-	-	-
Pilea pumila	X	X	X
Polygonum arifolium	-	-	-
Polygonum coccineum	X	X	X
Polygonum hydropiper	-	-	X
Polygonum hydropiperoides	-	-	X
Polygonum lapathifolium	X	X	X

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Polygonum orientale	-	-	-
Polygonum pensylvanicum	X	X	X
Polygonum persicaria	X	X	X
Polygonum punctatum	X	X	X
Polygonum sagittatum	X	-	X
Polygonum scandens	-	X	X
Pontedria cordata	-	X	X
Potentilla anserina	-	X	-
Potentilla fruticosa	-	-	-
Potentilla palustris	-	X	-
Potentilla paradoxa	-	-	-
Pycnanthemum virginianum	-	-	-
Ranunculus abortivus	-	-	X
Ranunculus bulbosa	-	-	-
Ranunculus fasicularis	X	-	-
Ranunculus flabellaris	-	-	-
Ranunculus hispidus	-	-	X
Ranunculus longirostris	-	X	-
Ranunculus pensylvanicus	-	-	X
Ranunculus repens	X	-	-
Ranunculus sceleratus	X	X	X
Ranunculus septentrionalis	-	-	-
Rorippa palustris	X	X	X
Rorippa sessiliflora	-	-	-
Rorippa sylvestris	-	X	X
Rotala ramosior	-	-	-
Rumex maritimus	-	-	X
Rumex orbiculatus	X	-	X
Rumex verticillatus	X	X	X
Sagittaria brevirosta	-	-	-
Sagittaria cuneata	-	-	-
Sagittaria graminea	-	-	-
Sagittaria latifolia	X	X	X
Sagittaria rigida	-	X	X
Sambucus canadensis	X	X	X

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Samolus parviflorus	-	-	X
Satureja arkansana	-	-	-
Saururus cernuus	X	-	-
Scheuchzeria palustris	-	-	-
Scirpus acutus	-	X	X
Scirpus americanus	X	X	X
Scirpus atrovirens	X	X	X
Scirpus cyperinus	-	X	X
Scirpus expansus	-	-	-
Scirpus fluviatilis	X	X	X
Scirpus georgianus	-	-	-
Scirpus heterochaetus	-	-	-
Scirpus pendulus	-	X	X
Scirpus polyphyllus	-	-	-
Scirpus smithii	-	-	-
Scirpus torreyi	-	-	-
Scirpus validus	X	X	X
Scutellaria epilobiifolia	X	X	X
Scutellaria lateriflora	X	X	X
Sicyos angulatus	-	X	X
Sium suave	-	X	-
Solanum dulcamara	X	X	X
Solanum nigrum	X	X	X
Solidago graminifolia	-	X	X
Sparganium americanum	-	-	-
Sparganium eurycarpum	X	X	X
Spartina pectinata	-	X	X
Stachys palustris	-	X	-
Stachys tenuifolia	X	-	X
Strophostyles helvola	X	X	X
Triglochin palustre	-	-	-
Typha angustifolia	X	X	X
Typha x glauca	-	-	-
Typha latifolia	X	X	X
Vaccinium macrocarpon	-	-	-

Table 6 continued

Taxa	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Verbena hastata	X	X	X
Verbena x illicita	X	-	-
Verbena simplex	-	-	-
Verbena urticifolia	-	X	X
Verbena scutellata	-	-	-
Zizania aquatica	-	-	X

Table 7

Summary of Tables 5 and 6

	Southwestern Lake Erie (Regional Standard)	Old Woman Creek Estuary	East Harbor State Park	Winous Point
Number of Aquatic Species	47	8	19	19
Percentage of the Regional Standard for Aquatic Species	100%	17%	40%	40%
Number of Wetland Species	246	82	130	115
Percentage of the Regional Standard for Wetland Species	100%	33%	53%	47%
Total Number of Aquatic and Wetland Species	293	90	149	134
Percentage of the Regional Standard (Total)	100%	31%	51%	46%

Analysis of the Prairie Area

While Ohio is considered a forest state, it does in fact have some prairies, such as the Oak Openings west of Toledo in Lucas County, the Castalia Prairie west of Castalia in Erie County, and the Lynx Prairie in eastern Adams County. At the time of settlement by European man, it is believed that roughly two percent of the state was prairie, mostly composed of small patches (Gilfillan, 1960). Located on the western uplands of the study area, on the north side of the railroad right-of-way is an old field. This site is unlike many old fields in the area, in that its species composition includes many plants commonly associated with prairie habitats in Ohio. Within the prairie habitat, no standard set of taxa alone may be used to define a prairie flora. However, several species frequently occurring in prairie sites may indicate a prairie association. Eleven species common in the old field at Old Woman Creek are listed in Table 8. Presence at a given prairie site is indicated by an "x". Those species occurring in all sites listed are:

Andropogon gerardi	Asclepias syriaca
Sorghastrum nutans	Lespedeza capitata

Jones (1944) lists four species thought to be dominant among Ohio's prairie flora. These include Andropogon gerardi, A. scoparius, Sorghastrum nutans and Spartina michauxiana. Jones states that it is quite unlikely that any one prairie site would contain all the species which he lists as dominants. It is significant that in the Old Woman Creek site Andropogon gerardi and Sorghastrum nutans are the

codominant species. This indicates that this small area may be a true prairie, based on Jone's prairie concept. As defined by Gordon (1969), the true Ohio prairie is open grassland, dominated by Andropogon gerardi. Further confirmation of a true prairie flora lies in the fact that all of the major species at the Old Woman Creek site occur in at least three of the four areas surveyed, with the exceptions of Silphium trifoliatum and Lespedeza virginia. Physical aspects of the Old Woman Creek site, considered below, also indicate the presence of a true prairie.

As many prairie remnants occur throughout northwestern Ohio (Anderson, 1971), it could be that this site at Old Woman Creek is a remnant of the original Ohio prairie. However, the evidence suggests that this site is a recently established prairie. The soil in this site is Sisson loamy fine sand (Redman, et al., 1971) in which one may detect charred material, indicating a recent fire. The exact time of occurrence of this fire is unknown. Judging from the stature of saplings in the site, it may be inferred that the fire occurred between 1965 and 1970. The area is situated on a high bluff which is subject to exposure to westerly and southerly winds. All of the conditions are favorable to the establishment of prairie flora as Vestal (1918) reports,

> "Among those (factors) which favor the development into prairie area: coarse well-drained soil; considerable exposure to wind and sun, as presented by certain topographic situations; deficiency of rainfall during one critical or several successive growing seasons; and the destructive effects of burning or mowing, both of which are common on (railroad) rights-of-way."

Transeau (1935) states that numerous small prairie patches occurred as far eastward as north-central Ohio, some presisting to the present time. Therefore, the presence of propagules of prairie species would be expected in the vicinity of Old Woman Creek. This being the case, the development of the prairie site at Old Woman Creek may simply be the result of favorable topographic and soil conditions which have permitted the establishment of the prairie flora following the clearing of the forest by fire. It is quite likely that barring any subsequent burning or clearing efforts, this area will revert to forest vegetation, as evidenced by the presence of saplings of Carya ovata, Sassafras albidum and Quercus sp.

Table 8

Species Composition of Selected Prairie Areas

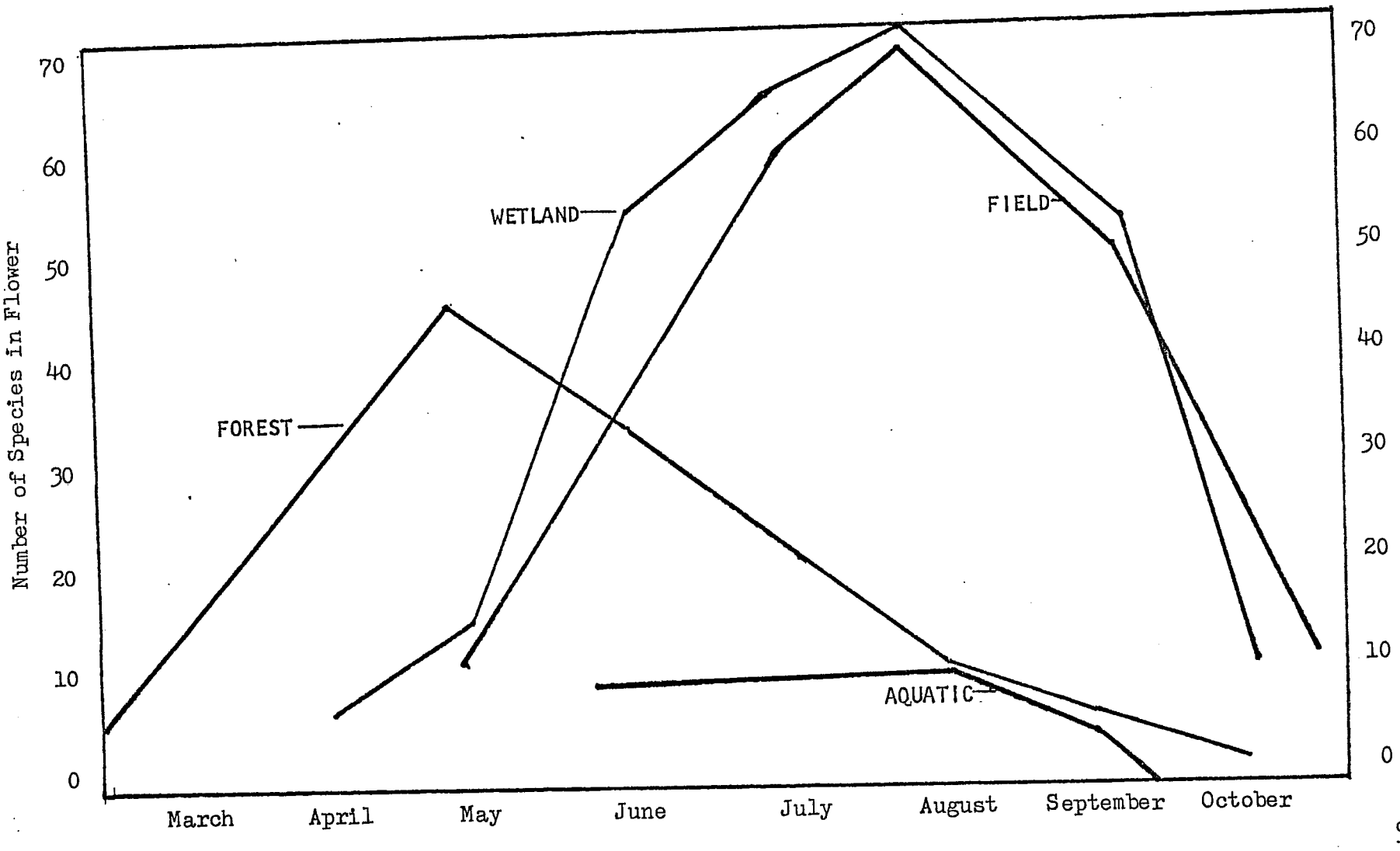
Prairie-related taxa occurring in the old field adjacent to the railroad, Old Woman Creek, Erie County, Ohio	Hurst (1971) Castalia Prairie, Erie County, Ohio	Anderson (1971) Northwestern Ohio Prairie Remnants	Jones (1944) Prairies of Ohio	Vestal (1914) Prairies of black-soil, Northeastern Illinois
Andropogon gerardi	X	X	X	X
Sorghastrum nutans	X	X	X	X
Asclepias tuberosa	X	X	X	X
Lespedeza capitata	X	X	X	X
Panicum virgatum		X	X	X
Asclepias syriaca	X	X		X
Euphorbia corollata	X		X	X
Anemone virginiana	X	X	X	
Spiranthes cernua	X	X		X
Silphium trifoliatum			X	
Lespedeza virginia	X			

*X indicates occurrence in a given area.

Analysis of Flowering Phenology

The flowering phenology of some showy species within the study area (Figures 8 and 9), is included to demonstrate the consistency of the area's aesthetic appeal. From the beginning of March through the end of October, an array of plants are in flower. Figures 8 and 9 exclude many species which are less showy in their floral display, even though they may be of interest to the amatuer or professional botanist. For the flowering phenology of species not listed in figures 8 and 9 the reader is referred to the catalog of the vascular plants in the appendix. Figure 10 is a more complete representation of the continuous production of flowers by the various species occurring in the study area. Peak flowering time for species occurring in the forest is late April and early May, owing to the early flowering periods of trees and understory herbaceous plants. Peak flowering times for aquatic and wetland plants, as well as old field species, is much later, in August. However, in field and wetland species flowering begins in May and April, respectively. The flowering season for species occurring in the open water habitat is short-lived by comparison, being only three months in duration, commencing in June.

Figure 7. Flowering Phenology of the Vascular Plants by Habitat Type



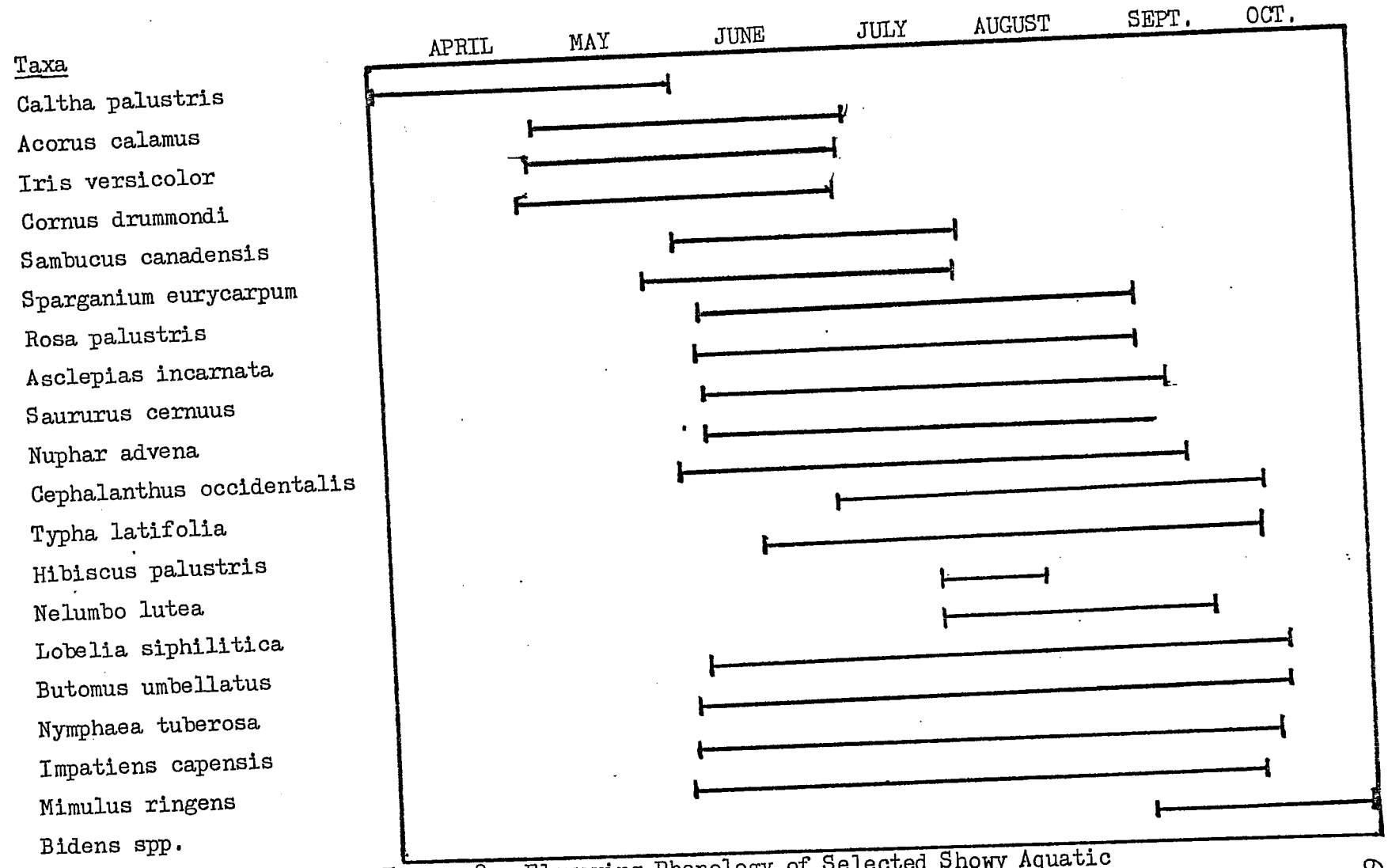


Figure 8. Flowering Phenology of Selected Showy Aquatic and Wetland Species.

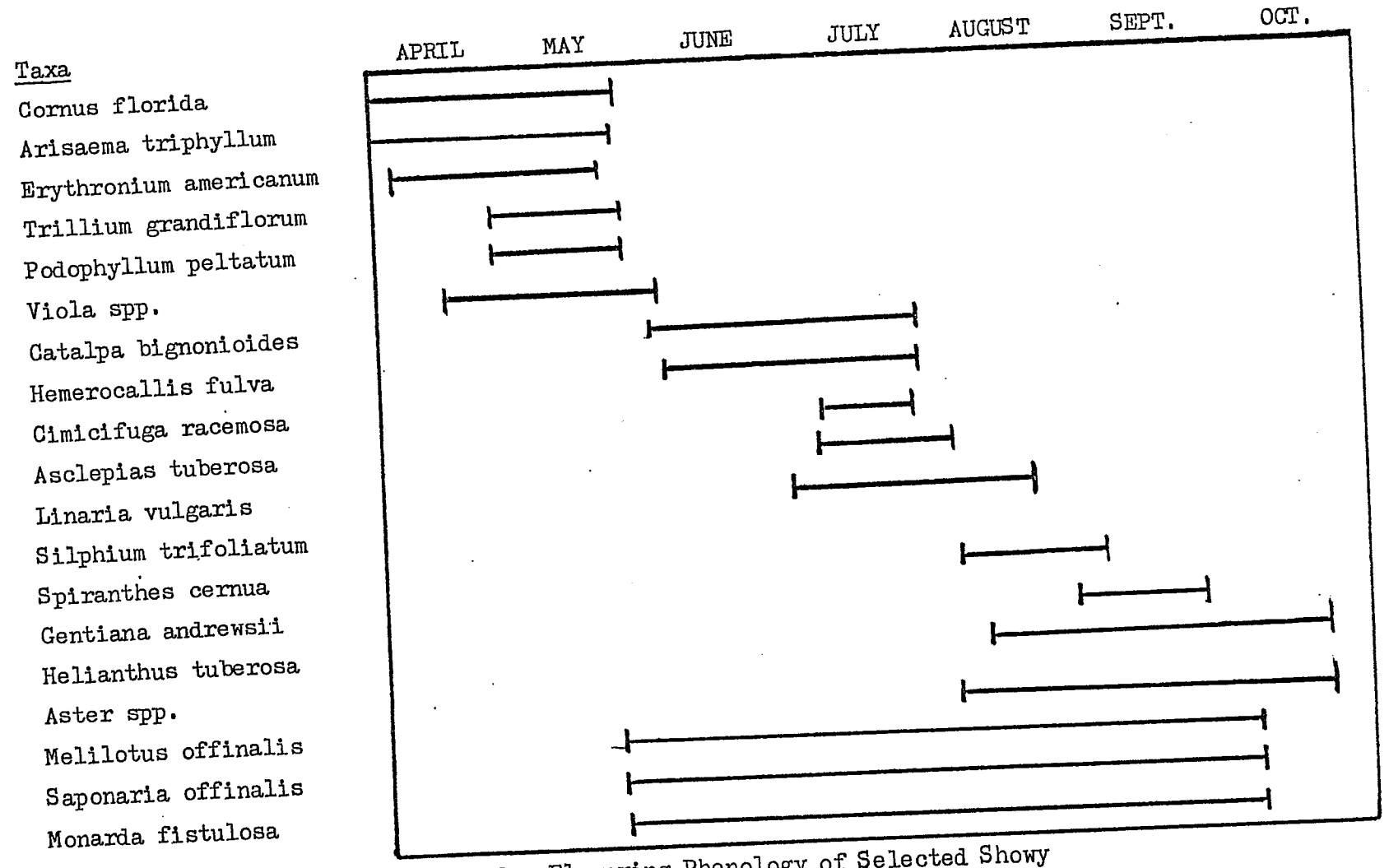


Figure 9. Flowering Phenology of Selected Showy Terrestrial Species.

CONCLUSIONS

The Old Woman Creek Estuary and its contiguous non-agricultural uplands represent one of Ohio's few remaining undeveloped lake front areas. While it is undeveloped, the area has been altered by Lake Erie and the activities of man. This environmental alteration is reflected in both its physical and floristic aspects.

Persistant high water levels of Lake Erie have caused the inundation of the lower floodplain of Old Woman Creek. This inundation has resulted in a reduction of available marsh habitat, and an increase in the shallow open water habitat. Short period vertical oscillations of Lake Erie cause related fluctuations in the water level of the estuary. However, these minor fluctuations are not sufficiently pronounced as to cause aberrations in the growth forms of wetland plants, common in the salt marshes of the northeastern United States.

While the open water habitat in the estuary is extensive, there is a conspicuous lack of diversity of aquatic plants. The majority of the open water area is very shallow and subject to wind and wave action. It also supports a large population of carp. These two factors coupled with the highly turbid incoming water result in consistently high turbidity levels within the estuary. High turbidity and the feeding and spawning habits of carp, which uproots plants, account for the low diversity and numbers of

aquatic plants in this habitat.

Throughout the study area, species with widespread distributions (Widespread, Widespread in the Eastern United States) are most prevalent, comprising 81 percent of the indigenous flora. Species of restricted distributions and narrow ecological tolerance (Eastern, Southern, Western) are less abundant throughout the study area, comprising only 19 percent of the indigenous flora. These species are in general less abundant with the exceptions of Peltandra virginica and Nelumbo lutea, which thrive on the inundated floodplain. Upon a reduction of water level in the estuary, it is likely that marsh species would encroach upon the floodplain and a major alteration of species composition would result.

A significant portion of the flora is composed of non-indigenous species (26 percent). This high percentage is indicative of environmental disturbance. However, 26 percent is not an unusually high percentage of non-indigenous plants when compared with comparably disturbed areas of urbanization and agriculture. Disturbance in the Old Woman Creek area results from both the activities of man and the effects of wind and wave action on Lake Erie. Three disturbed areas, the lake shore, United States Route 6 and the railroad, contiguous with eastern North American seaports, cross Old Woman Creek. These areas may serve as corridors of migration for non-indigenous taxa, as indicated by the migration routes of species such as Butomus umbellatus and Epipactis latifolia.

The diversity and abundance of aquatic and wetland species in the Old Woman Creek Estuary is low in comparison to other wetland areas of western Lake Erie. The conspicuous lack of diversity in aquatic species is thought to be due primarily to high turbidity levels which restrict the establishment of submersed aquatic plants. In wetland species, factors limiting species diversity and abundance are related to the inundation of the stream's floodplain. In the past, an extensive marsh occupied the floodplain. Currently, wetland species are restricted to a few remnant embayment marshes. These marshes occur in areas which are subject to considerable shading from nearby trees, hence incident light is severely restricted. Therefore, the limitation of species diversity and abundance for wetland plants in the Old Woman Creek Estuary results from a lack of suitable marsh habitat. Poorly represented genera in the Old Woman Creek Estuary include Carex, Eleocharis, Juncus and Scirpus, the sedges and rushes. These genera are principal components of the region's well-developed marshes, where they thrive on extensive mudflats or in shallow water. The lack of this type of habitat in the Old Woman Creek Estuary explains the low diversity of these genera. In the event of substantially lower water levels, the floodplain of Old Woman Creek should revert to larger marshes and mudflats, a condition conducive to the establishment of additional wetland species.

The flora of the old field northwest of the railroad trestle is quite distinctive from that of other old fields in the vicinity

of the study area. Here, Andropogon gerardi and Sorghastrum nutans are the co-dominant species. Both of these species are thought by Jones (1944) to be dominant among the species present in Ohio's prairie areas. Other species occurring in this site are also associated with other prairie floras in Ohio. Physical evidence at the site suggests that the prairie flora has been recently established, following a fire. The occurrence of a fire and the topographic situation at the site are factors which Vestal (1918) cites as favoring the establishment of prairie. The prairie flora is likely to be short-lived, barring any future clearing or burning, as evidenced by the establishment of young forest species throughout the site.

Throughout the study area, plants in flower may be observed from March through October. The peak flowering time for forest species occurs in late April and early May, while the peak flowering time for aquatic, wetland and old field (prairie) species occurs in August. The longest flowering season is associated with forest species, while the shortest flowering time, only three months in duration, is associated with aquatic species.

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Appendix

CATALOG OF THE VASCULAR PLANTS

The catalog follows the order and nomenclature presented in The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada (Gleason, 1952). The following is a graphical representation of the catalog entry:

Plant name Author. Location of collection (collection number(s)). Common name. Flowering time. Relative abundance. Geographical Affinity.

One of four frequency values is assigned to each plant species. These values represent the abundance of the species relative to other species occurring throughout the entire study area. These include:

Abundant -- several to many individuals in nearly all sites.
Common -- several to many individuals in many sites.
Occasional -- several individuals in more than one site.
Rare -- one to several individuals in one site.

The data on aquatic and wetland plants in this catalog are taken largely from Marshall and Stuckey (1974).

EQUISETACEAE - HORSETAIL FAMILY

Equisetum arvense L. Old field northwest of the railroad trestle (469).
Common Horsetail. April-July. Occasional. Widespread.

OSMUNDACEAE - ROYAL FERN FAMILY

Osmunda cinnamomea L. Woodland southeast of the railroad trestle (502).
Cinnamon Fern. April-May. Occasional. Eastern.

POLYPODIACEAE - POLYPODY FAMILY

Onoclea sensibilis L. Northern side of Star Island (452).
Sensitive Fern. June-October. Occasional. Widespread in the Eastern United States.

PINACEAE - PINE FAMILY

Pinus strobus L. Woodland northwest of Station E (361).
White Pine. Rare. Introduced from the Northeastern United States.

TYPHACEAE - CATTAIL FAMILY

Sparganium eurycarpum Engelm. Station E (115).
Bur-reed. June-September. Occasional. Widespread.

Typha angustifolia L. Station B (488).
Narrow-leaved Cattail. June-September. Rare. Eastern.

Typha latifolia L. Southwestern shoreline of the barrier beach (156).
Broad-leaved Cattail. July-August. Occasional. Widespread.

NAJADACEAE - PONDWEED FAMILY

Potamogeton nodosus Poir. Station I (271).
Pondweed. August-September. Rare. Southern.

Potamogeton pectinatus L. Station I (104).
Sago Pondweed. July-August. Common. Widespread.

ALISMACEAE - WATER-PLANTAIN FAMILY

Sagittaria latifolia Willd. Southwestern shoreline of the barrier beach (269).
Arrowhead. July-September. Occasional. Widespread.

BUTOMACEAE - FLOWERING RUSH FAMILY

Butomus umbellatus L. Northwestern side of Route 6 bridge (108).
Flowering Rush. June-September. Rare. Naturalized from Europe.

GRAMINEAE - GRASS FAMILY

Aegilops cylindrica Host. Along the railroad by G.T. Jones, 23 June, 1974 (217,888,OC).
Goat Grass. July-September. Rare. Naturalized from Europe.

Andropogon gerardi Vitm. Northwestern shoreline at the railroad (268).
Bluestem Grass. August-September. Occasional. Widespread.

Bromus japonicus Thunb. Station B (181).
Brome Grass. July-August. Rare. Naturalized from Eurasia.

Calamagrostis canadensis (Michx.) Beauv. Eastern stream bank at Station IV (283).
Blue-joint Grass. June-September. Occasional. Western.

Cinna arundinacea L. Small embayment in northeastern corner of Station III (246).
Wood Reed. August. Rare. Southern.

Digitaria sanguinalis (L.) Scop. Barrier beach (331).
Crab Grass. September-October. Rare. Naturalized from Europe.

Echinochloa crusgalli (L.) Beauv. Barrier beach (316).
Barnyard Grass. September. Rare. Naturalized from Europe.

Echinochloa pungens Rydb. Station B (188).
Barnyard Grass. July-September. Occasional. Widespread in the Eastern United States.

Echinochloa walteri (Pursh.) Nash. Northwestern side of Route 6 bridge (311).
Barnyard Grass. September. Rare. Introduced from the east coast of the United States.

Elymus virginicus L. West bank at Station B (147).
Wild Rye. July-September. Occasional. Widespread.

Eragrostis pectinacea (Michx.) Nees. Barrier Beach (235)
Love Grass. August-September. Rare. Widespread.

Glyceria striata (Lam.) Hitchc. Clearing directly west of Star Island (304).
Manna Grass. May-September. Rare. Widespread in the Eastern United States.

Leersia oryzoides (L.) Sw. Eastern stream bank at Station IV (280).
Cut Grass. August. Common. Widespread.

Panicum capillare L. Barrier beach (318).
Witch Grass. September. Rare. Widespread in the Eastern United States.

Panicum virgatum L. Old field northwest of the railroad trestle (472).
Panic Grass. July-September. Occasional. Widespread.

Phalaris arundinacea L. Southwestern streambank at the railroad (103).
Reed Canary Grass. June-September. Abundant. Naturalized from Europe.

Phleum pratense L. West bank at Station B (148).
Timothy. July-August. Occasional. Introduced and naturalized from Europe.

Poa pratensis L. West bank at Station B (149).
Kentucky Blue Grass. May-August. Occasional. Widespread.

Setaria glauca (L.) Beauv. Barrier beach (326).
Foxtail Grass. September. Occasional. Naturalized from Eurasia.

Setaria faberii Herrm. Station B (309).
Foxtail Grass. August-September. Common. Introduced from China.

Sorghastrum natans (L.) Nash. Old field northwest of the railroad trestle (500).
Indian Grass. September. Occasional. Widespread in the Eastern United States.

CYPERACEAE - SEDGE FAMILY

Carex frankii Kunth. Station B (187).
Sedge. June-July. Rare. Southern.

Carex vulpinoidea Michx. Station B. (186).
Sedge. June-July. Rare. Widespread.

Cyperus engelmannis Steud. Station A (279).
Umbrella-sedge. August-September. Occasional. Western.

Cyperus esculentus L. Barrier beach (328).
Umbrella-sedge. September. Occasional. Widespread.

Cyperus ferruginescens Boeckl. Barrier beach (216).
Umbrella-sedge. September. Common. Widespread.

Cyperus rivularis Kunth. Barrier beach (334).
Umbrella-sedge. September. Rare. Widespread in the Eastern United States.

Cyperus strigosus L. Western Bank at Station B (289).
Umbrella-sedge. September. Occasional. Widespread.

Scirpus americanus Pers. Western end of the barrier beach (234).
Bulrush. July-August. Rare. Widespread in the Eastern United States.

Scirpus atrovirens Willd. Station B (184).
Dark Green Bulrush. June-August. Occasional. Widespread in the Eastern United States.

Scirpus validus Vahl. Station B (183).
Great Bulrush. July-August. Occasional. Widespread.

ARACEAE - ARUM FAMILY

Acorus calamus L. Western shoreline of Station IV (516).
Sweet Flag. May-June. Rare. Widespread.

Arisaema atrorubens (Ait.) Blume Station C (417,420).
Jack-in-the-pulpit. April-May. Common. Widespread in the Eastern United States.

Peltandra virginica (L.) Kunth. Western shoreline behind the barrier beach (154).
Arrow Arum. May-June. Abundant. Eastern.

LEMNACEAE - DUCKWEED FAMILY

Lemna minor L. Station A (281).
Duckweed. June-August. Abundant. Widespread.

Spirodela polyrhiza (L.) Schleiden. Station A (281).
Duckweed. June-August. Abundant. Widespread.

JUNCACEAE - CRUSH FAMILY

Juncus effusus L. Station B (254).
Rush. August. Rare. Widespread in the Eastern United States.

Juncus tenuis Willd. Northwestern shoreline at the railroad (205).
Path Rush. May-July. Occasional. Widespread.

LILIACEAE - LILY FAMILY

Allium sativum L. Western shoreline of Station I (458).
Garlic. May-June. Occasional. Introduced from the Old World.

Asparagus officinalis L. Upland on south side of Star Island (250).
Garden Asparagus. May-June. Occasional. Introduced from Europe.

Erythronium americanum Ker. Inlet between Stations B and C (414).
Dog-tooth Violet. April-May. Occasional. Widespread in the Eastern United States.

Hemerocallis fulva L. North side of Route 6 along the shoreline (510).
Day Lily. June-July. Rare. Introduced from Asia.

Polygonatum biflorum (Walt.) Ell. Inlet between Stations B and C (415).
Solomon's Seal. May-July. Occasional. Widespread in the Eastern United States.

Smilacina racemosa (L.) Desf. Upland on east side of Star Island (106).
False Solomon's Seal. May-June. Occasional. Widespread in the Eastern United States.

Trillium grandiflorum (Michx.) Salisb. Northeastern woodland of Star Island (401). May. Abundant. Widespread in the Eastern United States.

AMARYLLIDACEAE - AMARYLLIS FAMILY

Hypoxis hirsuta (L.) Cov. Western shoreline north of the trestle (428).
Star Grass. April-July. Occasional. Southern.

IRIDACEAE - IRIS FAMILY

Iris versicolor L. Southwestern shoreline at the railroad (100).
Western shoreline of Station I (288). Western.
Blue Flag. May-June. Common.

ORCHIDACEAE - ORCHID FAMILY

Epipactis latifolia (L.) Crantz. One plant taken on steep northwestern bank at the railroad (137).
Helleborine. July-August. Rare. Introduced and Adventive from Europe.

Spiranthes cernua (L.) Rich. Old field northwest of the railroad trestle (498).
Ladies' Tresses. August-September. Occasional. Widespread in the Eastern United States.

SAURURACEAE - LIZARD'S-TAIL FAMILY

Saururus cernuus L. Station C (113,128).
Lizard's-tail. June-August. Rare. Southern.

SALICACEAE - WILLOW FAMILY

Populus deltoides Marsh. Barrier beach (324).
Cottonwood. April-May. Occasional. Widespread.

Populus grandidentata Michx. Station C (359).
Large-toothed Aspen. April. Occasional. Widespread in the Eastern United States.

Salix spp. L. Barrier beach (330); Western streambank south of the trestle (437).
Willow. April-May. Occasional.

JUGIANDACEAE - WALNUT FAMILY

Carya cordiformis (Wang.) K. Koch. Observed in woods on the western side of the estuary, no collection made.
Bitternut. May-June. Occasional. Widespread in the Eastern United States.

Carya ovata (Mill.) K. Koch. Woodlands adjacent to Station E (363).
Shagbark Hickory. May. Common. Widespread in the Eastern United States.

Juglans nigra L. Observed on the western shoreline of Station I, no collection made.
Black Walnut. April-May. Occasional. Widespread in the Eastern United States.

BETULACEAE - BIRCH FAMILY

Alnus serrulata (Ait.) Willd. At water's edge on lower Old Woman Creek by G.T. Jones, 6 July, 1975 (218,232,OC).
Smooth Alder. March-April. Occasional. Widespread in the Eastern United States.

Corylus americana Walt. Observed in woods on western side of the estuary, no collection made.
Hazel. March-April. Occasional. Widespread in theEastern United States.

Ostrya virginiana (Mill.) K. Koch. South facing slope near the mouth of Old Woman Creek by G.T. Jones, 6 July, 1975 (218, 233,OC).
Hop Hornbeam. April-May. Occasional. Widespread in the Eastern United States.

FAGACEAE - BEECH FAMILY

Quercus alba L. Woodlands adjacent to Station E (360).
White Oak. May-June. Common. Widespread in the Eastern United States.

Quercus borealis Michx. F. Observed throughout the woods on the eastern side of the estuary, no collection made.
Red Oak. May-June. Occasional. Widespread in the Eastern United States.

Quercus palustris Muenchh. Observed throughout the woods on the eastern side of the estuary, no collection made.
Pin Oak. May-June. Common. Southern.

ULMACEAE - ELM FAMILY

Ulmus rubra Muhl. Woodlands adjacent to Station E (365).
Slippery Elm. March-April. Occasional. Widespread in the Eastern United States.

URTICACEAE - NETTLE FAMILY

Boehmeria cylindrica (L.) Sw. Northwestern shoreline at the railroad (243).
False Nettle. July-August. Common. Widespread in the Eastern United States.

Laportea canadensis (L.) Gaud. Small embayment in the northeastern corner of Station III (240).
Wood Nettle. July-August. Common. Widespread in the Eastern United States.

Pilea pumila (L.) Gray. Small embayment in the northeastern corner of Station III (242).
Clear Weed. July-September. Common. Widespread in the Eastern United States.

Urtica dioica L. Station B (179).
Nettle. June-August. Occasional. Naturalized from Eurasia.

SANTALACEAE - SANDAL-WOOD FAMILY

Comandra umbellata (L.) Nutt. Under oaks in dry woods lower Old Woman Creek by G.T. Jones, 6 July, 1975 (218,239,OC).
Bastard-toad-flax. May-July. Rare. Widespread in the Eastern United States.

POLYGONACEAE - SMARTWEED FAMILY

Polygonum coccineum Muhl. Station V (218).
Water Smartweed. August-September. Common. Widespread.

Polygonum convolvulus L. Along margin of farm land at Station A (508).
Black Bindweed. June-September. Rare. Naturalized from Europe.

Polygonum lapathifolium L. Clearing directly west of Star Island (226).
Nodding Smartweed. August-September. Common. Widespread.

Polygonum pensylvanicum L. Clearing directly west of Star Island (306).
Pinkweed. August-September. Common. Widespread in the Eastern United States.

Polygonum pensylvanicum L. var. eglandulosum Myers. One plant taken on the barrier beach by Dr. R.L. Stuckey, 18 September 1974 (9550,OS).
Pinkweed. August-September. Rare. Adventive.

Polygonum persicaria L. Northern shoreline of Station III (267).
Lady's-thumb. July-September. Occasional. Naturalized from Europe.

Polygonum punctatum Ell. Northwest side of Route 6 bridge (349).
Water Smartweed. August-September. Occasional. Widespread in the Eastern United States.

Polygonum sagittatum L. Clearing directly west of Star Island (303).
Arrow-vine. September. Rare. Widespread in the Eastern United States.

Polygonum virginianum L. Station C (204).
Jumpseed. August. Rare. Widespread in the Eastern United States.

Rumex crispus L. Station B (161).
Sour Dock. June-September. Occasional. Naturalized from Europe.

Rumex orbiculatus Gray. Station E (299).
Great Water Dock. September. Rare. Western.

Rumex verticillatus L. Station C (116).
Water Dock. June-September. Common. Southern.

CHENOPODIACEAE - GOOSEFOOT FAMILY

Chenopodium album L. Barrier beach (332).
Lamb's Quarters. September. Rare. Naturalized from Europe.

Cycloloma atriplicifolium (Spreng.) Coult. Barier beach (327).
Winged Pigweed. September. Rare. Naturalized from the Western United States.

Salsola kali L. Barrier beach (312).
Russian Thistle. August-September. Rare. Naturalized from the Western United States.

AMARANTHACEAE - AMARANTH FAMILY

Amaranthus albus L. Observed on the barrier beach, no collection made.
Tumbleweed. September. Rare. Naturalized from the Western United States.

Amaranthus retroflexus L. Barrier beach (215).
Pigweed. August-September. Occasional. Naturalized from Tropical America.

NYCTAGINACEAE - FOUR-O'CLOCK FAMILY

Mirabilis nyctaginea (Michx.) MacM. Observed on the barrier beach, no collection made.
Four-O'clock. September. Rare. Naturalized from the Western United States.

PHYTOLACCACEAE - POKEWEED FAMILY

Phytolacca americana L. Western bank at Station B (143).
Pokeweed. June-August. Occasional. Southern.

PORTULACACEAE - PURSLANE FAMILY

Portulaca oleracea L. Observed on the barrier beach, no collection made.
Purslane. June-September. Rare. Naturalized from Europe.

CARYOPHYLLACEAE - PINK FAMILY

Saponaria officinalis L. Roadside at Station B (209).
Bouncing Bet. June-September. Occasional. Naturalized from Europe.

CERATOPHYLLACEAE - HORNWORT FAMILY

Ceratophyllum demersum L. Station IV (515).
Coontail. July-September. Rare. Widespread

NYMPHAEACEAE - WATER-LILY FAMILY

Nelumbo lutea (Willd.0 Pers. Station II (189,190,200).
Lotus Lily. August. Abundant. Southern.

Nuphar advena Ait. Station IV (111); Swamp forest south of the railroad (464).
Yellow Water-lily. June-August. Occasional. Widespread in the Eastern United States.

Nymphaea tuberosa Paine. Station IV (101).
White Water-lily. June-September. Common. Widespread in the Eastern United States.

RANUNCULACEAE - CROWFOOT FAMILY

Anemonella thalictroides (L.) Spach. Northern end of Star Island (404).
Rue Anemone. April-May. Occasional. Widespread in the Eastern United States.

Anemone quinquefolia L. Station C (421).
Wood Anemone. April-June. Rare. Widespread in the Eastern United States.

Anemone virginiana L. Old field northwest of the trestle (470).
Wind Flower. June-August. Occasional. Widespread in the Eastern United States.

Caltha palustris L. Station C (424).
Marsh Marigold. April-May. Occasional. Widespread.

Cimicifuga racemosa (L.) Nutt. Wooded uplands between Station III and the railroad (119).
Black Snakeroot. July. Common. Widespread in the Eastern United States.

Clematis virginiana L. The railroad at the trestle (490).
Virgin's Bower. July-August. Occasional. Widespread in the Eastern United States.

Ranunculus fascicularis Muhl. Station C (443).
Buttercup. April-May. Common. Widespread in the Eastern United States.

Ranunculus repens L. Station C (418).
Buttercup. May-July. Common. Naturalized from Europe.

Ranunculus sceleratus L. Western streambank south of the railroad (442).
Cursed Crowfoot. June-September. Common. Widespread.

Thalictrum dioicum L. Northern end of Star Island (402).
Meadow Rue. May. Common. Widespread in the Eastern United States.

BERBERIDACEAE - BARBERRY FAMILY

Podophyllum peltatum L. Eastern side of Star Island (430).
May Apple. May. Common. Widespread in the Eastern United States.

LAURACEAE - LAUREL FAMILY

Sassafras albidum (Nutt.) Nees. Northern side of Star Island (356).
Sassafras. April-May. Common. Widespread in the Eastern United States.

CRUCIFERAE - MUSTARD FAMILY

Alliaria officinalis Andrz. Western shoreline of Station I (409).
Garlic Mustard. May-June. Abundant. Introduced and naturalized from Europe.

Barbarea vulgaris R. Br. Observed on the barrier beach, no collection made.
Winter Cress. June. Rare. Naturalized from Europe.

Brassica campestris L. Eastern side of Star Island (432).
Field Mustard. May-October. Occasional. Naturalized from Eurasia.

Brassica hirta Moench. Barrier beach (274,322).
White Mustard. June-August. Occasional. Introduced from Eurasia.

Cardamine pensylvanica Muhl. Station E (217).
Bittercress. June-July. Common. Widespread.

Dentaria laciniata Muhl. Northern side of Star Island (403).
Toothwort. April-May. Occasional. Widespread in the Eastern United States.

Hesperis matronalis L. Western shoreline of Station I (444).
Dame's Rocket. May-June. Occasional. Introduced and naturalized from Europe.

Rorippa palustris (L.) Bess. var. hispida (Desv.) Rydb. Station B (175).
Marsh Cress. June-October. Common. Western.

CAPPARIDACEAE - CAPER FAMILY

Polanisia dodecandra (L.) DC. Barrier beach (273,323).
Clammy Weed. July-September. Rare. Southern.

CRASSULACEAE - ORPINE FAMILY

Penthorum sedoides L. Northwestern shoreline at the trestle (203).
Ditch Stonecrop. July-September. Rare. Widespread in the Eastern United States.

Sedum telephium L. On the railroad near the trestle (492).
Live-forever. August-September. Rare. Introduced from Eurasia.

SAXIFRAGACEAE - SAXIFRAGE FAMILY

Hydrangea arborescens L. On the railroad near the trestle (461).
Wild Hydrangea. June-July. Rare. Widespread in the Eastern United States.

Ribes sativum Syme. Northern shoreline of Station I (412).
Currant. April-June. Occasional. Introduced and naturalized from Europe.

ROSACEAE - ROSE FAMILY

Agrimonia gryposepala Wallr. Station B (174).
Agrimony. July-August. Common. Widespread.

Crataegus sp. L. Southern side of Star Island (431).
Hawthorn. May-June. Common.

Fragaria virginiana Duchesne. Southwestern shoreline of Station III (426).
Strawberry. April-June. Occasional. Widespread.

Geum canadense Jacq. Station A (263).
Avens. June. Occasional. Widespread in the Eastern United States.

Geum laciniatum Murr. Station B (176).
Avens. June. Occasional. Eastern.

Potentilla canadensis L. Northern side of Star Island (451).
Cinquefoil. April-June. Occasional. Eastern.

Prunus pensylvanica L.f. Western side of Star Island (400).
Pin Cherry. April-May. Occasional. Widespread.

Prunus serotina Ehrh. Station E (362).
Wild Cherry. May. Occasional. Widespread in the Eastern United States.

Rosa blanda Ait. Small embayment on the northwestern side of Star Island (453).
Smooth-stem Rose. June. Rare. Eastern.

Rosa multiflora Thunb. Northern side of Star Island (107).
Multiflora Rose. June-July. Occasional. Introduced and naturalized from Eastern Asia.

Rosa palustris Marsh. Station IV (275).
Swamp Rose. June-August. Common. Widespread in the Eastern United States.

Rosa setigera Michx. Upland on the south side of Star Island (107).
Prairie Rose. June-July. Occasional. Widespread in the Eastern United States.

Spiraea alba DuRoi. Northern shoreline of Station IV (130).
Meadow-sweet. June-August. Rare. Western.

FABACEAE - BEAN FAMILY

Astragalus canadensis L. Barrier beach (325).
Milk Vetch. July-August. Rare. Western.

Desmodium canadense (L.) DC. Northern side of Star Island (258).
Tick Trefoil. July-August. Common. Widespread in the Eastern United States.

Desmodium laevigatum (Nutt.) DC. Station B (480).
Tick Trefoil. July-August. Common. Western.

Lespedeza capitata Michx. Old field northwest of the railroad trestle (499).
Bush Clover. July-September. Occasional. Widespread in the Eastern United States.

Lespedeza virginica (L.) Britt. Northwestern shoreline at the railroad trestle (262).
Bush Clover. August-September. Rare. Widespread in the Eastern United States.

Melilotus alba Desr. Station B (177).
White Sweet Clover. July-September. Occasional. Naturalized from Europe.

Melilotus officinalis (L.) Desr. Old field northwest of the trestle (455).
Yellow Sweet Clover. June-September. Occasional. Naturalized from Europe.

Strophostyles helvola (L.) Ell. Station B (170,206).
Wild Bean. June-September. Common. Southern.

OXALIDACEAE - WOOD-SORREL FAMILY

Oxalis europaea Jord. Northeastern side of Route 6 (210).
Wood Sorrel. August. Occasional. Widespread.

POLYGALACEAE - MILKWORT FAMILY

Polygala verticillata L. Northwestern shoreline at the railroad trestle (123).
Milkwort. July-October. Occasional. Widespread in the Eastern United States.

EUPHORBIACEAE - SPURGE FAMILY

Acalypha rhomboidea Raf. Observed on the barrier beach, no collection made.
Three-seed Mercury. September. Rare. Widespread in the Eastern United States.

Euphorbia corollata L. Upland on the southwestern side of Star Island (247).
Flowering Spurge. June-September. Occasional. Widespread in the Eastern United States.

Euphorbia dentata Michx. On the railroad near the trestle (494).
Spurge. June-September. Occasional. Widespread in the Eastern United States.

ANACARDIACEAE - CASHEW FAMILY

Rhus glabra L. Margin of the railroad west of the railroad trestle (366).
Smooth Sumac. June-July. Common. Widespread.

Rhus radicans L. Observed throughout the estuary, no collection made.
Poison Ivy. June. Abudnant. Widespread in the Eastern United States.

Rhus typhina L. Center of Star Island (355).
Staghorn Sumac. June-August. Common. Widespread in the Eastern United States.

ACERACEAE - MAPLE FAMILY

Acer rubrum L. Station E (358).
Red Maple. March-April. Common. Widespread in the Eastern United Sates.

Acer saccharinum L. Observed on eastern bank at the mouth of the creek, no collection made.
Silver Maple. March-April. Occasional. Widespread in the Eastern United States.

BAISAMINACEAE - TOUCH-ME-NOT FAMILY

Impatiens capensis Willd. Northwestern shoreline at the trestle (221).
Touch-me-not. June-September. Abundant. Widespread.

Impatiens pallida Nutt. Northeastern bank of the trestle (237).
Pale Touch-me-not. June-September. Rare. Widespread.

VITACEAE - GRAPE FAMILY

Parthenocissus quinquefolia (L.) Planch. Station IV along the stream bank (513).
Virginia Creeper. June. Occasional. Widespread in the Eastern United States.

Vitis riparia Michx. Station IV along the stream bank (514).
Riverbank Grape. May-July. Common. Widespread.

MALVACEAE - MALLOW FAMILY

Abutilon theophrasti Medic. Barrier beach (313).
Velvet-leaf. July-October. Rare. Naturalized from India.

Hibiscus palustris L. Station B (194).
Rose Mallow. July-September. Common. Eastern.

Hibiscus trionum L. Barrier beach (335).
Flower-of-the-hour. September. Rare. Naturalized from Europe.

HYPERICACEAE - ST. JOHN'S WORT FAMILY

Hypericum perforatum L. Northwestern shoreline at the trestle (198).
St. John's Wort. June-September. Occasional. Naturalized from Europe.

Hypericum punctatum Lam. Station C (251).
St. John's Wort. August. Rare. Widespread in the Eastern United States.

VIOLACEAE - VIOLET FAMILY

Viola cucullata Ait. Southern side of Star Island (406).
Blue Marsh Violet. May. Common. Widespread in the Eastern United States.

Viola pubescens Ait. Station C (423).
Downy Yellow Violet. May. Occasional. Widespread in the Eastern United States.

Viola striata Ait. Stream bank between Stations IV and VIII (435).
Pale Violet. May. Occasional. Southern.

LYTHRACEAE - LOOSESTRIFE FAMILY

Decodon verticillatus (L.) Ell. Clearing directly west of Star Island (222).
Swamp Loosestrife. July-September. Occasional. Widespread in the Eastern United States.

ONAGRACEAE - EVENING-PRIMROSE FAMILY

Oenothera biennis L. Northwestern shoreline at the trestle (197).
Evening Primrose. July-September. Occasional. Widespread.

Epilobium glandulosum Lehm. Station A (265).
Willow-herb. July-September. Occasional. Widespread.

Gaura biennis L. Northwestern shoreline at the trestle (261).
Gaura. August-September. Occasional.. Southern.

Ludwigia palustris (L.) Ell. Observed on the barrier beach, no collection made.
Water-purslane. August. Rare. Widespread.

UMBELLIFERAE - PARSLEY FAMILY

Cicuta maculata L. Southwestern side of the railroad trestle on the stream bank (512).
Water Hemlock. June-August. Rare. Widespread in the Eastern United States.

Daucus carota L. Western shoreline at Station B (142).
Wild Carrot. June-September. Occasional. Naturalized from Europe.

CORNACEAE - DOGWOOD FAMILY

Cornus drummondii C. A. Meyers. Station E (105).
Dogwood. May-June. Common. Southern.

Cornus florida L. Southern side of Star Island (405).
Flowering Dogwood. April-May. Occasional. Widespread in the Eastern United States.

PRIMULACEAE - PRIMROSE FAMILY

Lysimachia ciliata L. Northwestern shoreline at the railroad trestle (122).
Fringed Loosestrife. July-September. Occasional. Widespread.

Lysimachia nummularia L. Station D (191).
Moneywort. June-August. Abundant. Introduced and naturalized from Europe.

Lysimachia quadrifolia L. Southern side of Star Island (460).
Loosestrife. June-July. Common. Widespread in the Eastern United States.

OLEACEAE - OLIVE FAMILY

Fraxinus americana L. Observe in woods on eastern side of the estuary, no collection made.
White Ash. April-June. Occasional. Widespread in the Eastern United States.

GENTIANACEAE - GENTIAN FAMILY

Gentiana andrewsii Griseb. Upland on the south side of Star Island (282).
Closed Gentian. September. Rare. Eastern.

APOCYNACEAE - DOGBANE FAMILY

Apocynum cannabinum L. On the railroad north of the trestle (493).
Indian Hemp. June-September. Occasional. Widespread.

Apocynum sibiricum Jacq. Shoreline west of Star Island (229).
Indian Hemp. June-July. Rare. Widespread.

ASCLEPIDACEAE - MILKWEED FAMILY

Asclepias incarnata L. Northern shoreline of Station III (114).
Swamp Milkweed. June-August. Common. Widespread.

Asclepias syriaca Engelm. On the railroad north of the trestle (463).
Milkweed. June-July. Occasional. Widespread in the Eastern United States.

Ascelpias syriaca L. Weedy roadside near mouth of Old Woman Creek by G.T. Jones, 6 July, 1975 (218,272,OC).
Milkweed. June-July. Occasional. Widespread in the Eastern United States.

Asclepias tuberosa L. Old field northwest of the trestle (120).
Butterfly-weed. July. Occasional. Widespread in the Eastern United States.

CONVOLULACEAE - MORNING-GLORY FAMILY

Convolvulus sepium L. Western shoreline at Station B (138).
Hedge Bindweed. June-September. Common. Widespread.

POLEMONIACEAE - PHLOX FAMILY

Phlox divaricata L. Station C (422).
Phlox. April-June. Occasional. Widespread in the Eastern United States.

HYDROPHYLLACEAE - WATERLEAF FAMILY

Hydrophyllum virginianum L. Station C (450).
Waterleaf. May-June. Occasional. Widespread in the Eastern United States.

VERBENACEAE - VERVAIN FAMILY

Verbena hastata L. Clearing directly west of Star Island (150).
Blue Vervain. June-October. Common. Widespread.

Verbena x illicita Moldenke. Station B (171).
Vervain. July-August. Rare.

LABIATAE - MINT FAMILY

Collinsonia canadensis L. Southern side of the railroad east of the trestle (503).
Horse-balm. July-September. Occasional. Widespread in the Eastern United States.

Lamium purpureum L. Northwestern shoreline of Station I (413).
Dead Nettle. April-October. Common. Naturalized from Europe.

Lycopus americanus Muhl. Station B (173).
Water Horehound. June-September. Rare. Widespread.

Lycopus europaeus L. Barrier beach (333).
Water Horehound. June-September. Rare. Naturalized from Europe.

Lycopus uniflorus Michx. Northwestern shoreline at the trestle (350).
Water Horehound. June-September. Occasional. Western.

Lycopus x sherardi Steele. Clearing directly west of Star Island (305).
Water Horehound. June-September. Rare.

Mentha arvensis L. Station E (320).
Mint. July-August. Common. Widespread.

Mentha x cardiaca Baker. Station B (167).
Mint. July-August. Rare. Naturalized from Europe.

Monarda fistulosa L. Southwestern side of Star Island (193).
Wild Bergamot. June-September. Occasional. Widespread in the Eastern United States.

Nepeta cataria L. Western shoreline at Station B (134).
Catnip. July-October. Occasional. Naturalized from Europe.

Prunella vulgaris L. Western shoreline at Station B (140).
Self-heal. June-October. Common. Widespread.

Scutellaria epilobiifolia L. Western shoreline of Station I (118).
Skullcap. June-August. Common. Western.

Scutellaria lateriflora L. Clearing directly west of Star Island (224).
Skullcap. July-September. Common. Widespread.

Stachys tenuifolia Willd. Clearing directly west of Star Island (219).
Hedge-nettle. June-August. Occasional. Eastern.

Teucrium canadense L. Station B (168).
Germander. June-August. Occasional. Widespread in the eastern United States.

SOLANACEAE - NIGHTSHADE FAMILY

Solanum dulcamara L. Station C (117).
Bittersweet Nightshade. June-September. Common. Introduced and naturalized from Europe.

Solanum nigrum L. Station A (257).
Black Nightshade. August-September. Occasional. Naturalized from Europe.

SCOPHULARIACEAE - FIGWORT FAMILY

Antirrhinum majus (L.) Lange. Northeastern side of Route 6 bridge (207).
Snapdragon. June-September. Rare. Introduced and adventive from Europe.

Chaenorrhinum minus (L.) Lange. Northeastern side of Route 6 bridge (208).
Lesser Toadflax. June-September. Occasional. Naturalized from Europe.

Chelone glabra L. Eastern streambank of Station IV (277).
Turtlehead. September. Occasional. Widespread in the Eastern United States.

Lindernia dubia (L.) Pennell. Observed on the barrier beach, no collection made.
False Pimpernel. July-September. Rare. Widespread.

Linaria vulgaris Hill. Steep bank on the northwestern side of the railroad trestle (126).
Butter-and-eggs. July-August. Rare. Naturalized from Europe.

Mimulus ringens L. Station B (159).
Monkey-flower. June-September. Occasional. Widespread in the Eastern United States.

Verbascum thapsus L. Clearing directly west of Star Island (255).
Mullein. June-September. Occasional. Naturalized from Europe.

Veronicastrum virginicum (L.) Farw. Old field northwest of the trestle (473).
Culver's Root. June-August. Occasional. Widespread in the Eastern United States.

BIGNONIACEAE - TRUMPET CREEPER FAMILY

Catalpa bignonioides Walt. Northern side of Star Island (465).
Catalpa. June-July. Rare. Introduced from farther south.

PHRYMACEAE - LOPSEED FAMILY

Phryma leptostachya L. Moist deciduous woods near mouth of Old Woman Creek by G.T. Jones, 6 July, 1975 (218,292,OC).
Lopseed. June-August. Rare. Widespread in the Eastern United States.

PLANTAGINACEAE - PLANTAIN FAMILY

Plantago major L. Observed on the barrier beach, no collection made.
Plantain. July-September. Rare. Naturalized from Europe.

RUBIACEAE - MADDER FAMILY

Cephalanthus occidentalis L. Southwestern shoreline of Star Island (110).
Bitton Bush. June-August. Common. Widespread.

Galium tinctorium L. Station C (127).
Bedstraw. June-August. Common. Widespread.

CAPRIFOLIACEAE - HONEYSUCKLE FAMILY

Lonicera japonica Thunb. Southeastern bank at the trestle (462).
Japanese Honeysuckle. May-September. Occasional. Naturalized from Asia.

Sambucus canadensis L. Northern shoreline of Star Island (121).
Common Elder. June-July. Occasional. Widespread in the Eastern United States.

Viburnum acerifolium L. Observed in woods on the western side of the estuary, no collection made.
Arrow-wood. May-June. Occasional. Eastern.

Viburnum prunifolium L. Observed in woods on eastern side of the estuary, no collection made.
Black Haw. April-May. Occasional. Widespread in the Eastern United States.

VALERIANACEAE - VALERIAN FAMILY

Valerianella radiata (L.) Dufr. South of Station IV (439).
Corn Salad. April-May. Occasional. Naturalized from farther south.

CUCURBITACEAE - GOURD FAMILY

Echinocystis lobata (Michx.) T. and G. Station A (233,307).
Wild Cucumber. July-September. Common. Southern.

LOBELIACEAE - LOBELIA FAMILY

Lobelia siphilitica L. Western shoreline of Star Island (278).
Great Lobelia. August-September. Occasional. Widespread in the Eastern United States.

COMPOSITAE - COMPOSITE FAMILY

Achillea millefolium L. Station D (132).
Yarrow. June-October. Occasional. Naturalized from Europe.

Ambrosia artemisiifolia L. Barrier beach (272).
Ragweed. August-September. Common. Widespread in the Eastern United States.

Ambrosia trifida L. Station B (487).
Ragweed. July-October. Common. Widespread.

Antennaria plantaginifolia (L.) Richards. Southwestern shoreline of Station III (427).
Pussy-toes. April-August. Occasional. Widespread in the Eastern United States.

Arctium minus Schk. Western shoreline at Station B (141).
Burdock. July-October. Occasional. Naturalized from Europe.

Aster azureus Lindl. Old field northwest of the trestle (506).
Aster. July-October. Occasional. Widespread in the Eastern United States.

Aster laevis L. Southern side of Star Island (286).
Aster. August-October. Occasional. Widespread in the Eastern United States.

Aster novae-angliae L. Old field northwest of the trestle (505).
New England Aster. July-October. Occasional. Widespread in the Eastern United States.

Aster praealtus Poir. Western shoreline at Station B (341).
Aster. September-October. Occasional. Widespread in the Eastern United States.

Aster sagittifolius Willd. Western shoreline at Station B (343).
Aster. August-October. Rare. Widespread in the Eastern United States.

Aster shortii Lindl. Southern side of Star Island (287).
Aster. August-October. Occasional. Widespread in the Eastern United States.

Aster undulatus L. Railroad margin west of the trestle (509).
Aster. August-October. Occasional. Widespread in the Eastern United States.

Bidens cernua L. Western shoreline at Station B (292,348).
Beggerticks. September-October. Common. Widespread.

Bidens connata Muhl. Observed on the barrier beach, no collection made.
Beggarticks. September-October. Occasional. Eastern.

Bidens frondosa L. Barrier beach (317,353).
Beggarticks. September-October. Common. Widespread.

Cacalia atriplicifolia L. On the railroad near the trestle (496).
Indian Plantain. July-September. Occasional. Widespread in the Eastern United States.

Chichorium intybus L. Western shoreline at Station B (145).
Chicory. July-October. Occasional. Naturalized from Europe.

Cirsium arvense (L.) Scop. Station B (166).
Canada Thistle. July-October. Occasional. Naturalized from Europe.

Eclipta alba (L.) Hassk. Barrier beach (314).
Yerbe-de-tage. August-October. Rare. Southern.

Erigeron philadelphicus L. Northwestern shoreline of Station I (446).
Daisy Fleabane. April-May. Occasional. Widespread.

Erigeron strigosus Muhl. Western shoreline at Station B (146).
Daisy Feabane. June-August. Rare. Widespread.

Eupatorium perfoliatum L. Station B (162).
Boneset. July-October. Occasional. Widespread in the Eastern United States.

Eupatorium rugosum Houtt. Woodland on the north side of Star Island (260).
White Snake-root. July-October. Occasional. Widespread in the Eastern United States.

Galinsoga parviflora Cav. Barrier beach (337).
Galisoga. June-October. Rare. Naturalized from Tropical America.

Helianthus tuberosus L. Old field northwest of the railroad trestle (476).
Jerusalem Artichoke. August-October. Occasional. Introduced from the Southern United States.

Hieracium venosum L. Southwestern shoreline of Station III (456).
Hawkweed. May-July. Occasional. Introduced from the Southern United States.

Lactuca canadensis L. Southeastern side of the trestle (497).
Lettuce. July-September. Occasional. Widespread.

Lactuca floridana (L.) Gaertn. var. floridana. Northeastern side of the Route 6 bridge (484).
Lettuce. June-September. Rare. Widespread in the Eastern United States.

Rudbeckia fulgida Ait. Station B (478).
Cone Flower. July-October. Rare. Widespread in the Eastern United States.

Senecio glabellus Poir. Station C (448).
Ragwort. May-July. Occasional. Adventive from the Southern United States.

Silphium trifoliatum L. Old field northwest of the trestle (468).
Rosin-weed. July-September. Common. Widespread in the Eastern United States.

Solidago canadensis L. Station B (284).
Goldenrod. July-September. Common. Widespread.

Solidago rugosa Mill. Upland on Star Island (285).
Goldenrod. August-October. Occasional. Widespread in the Eastern United States.

Solidago speciosa Nutt. Center of Star Island (248).
Goldenrod. August-October. Occasional. Widespread in the Eastern United States.

Taraxacum officinale Weber. Northern bank of Station I (410).
Common Dandelion. March-December. Abundant. Naturalized from Europe.

Vernonia altissima Nutt. Station B (297).
Ironweed. August-September. Occasional. Southern.

Xanthium strummarium L. Barrier beach (319).
Cocklebur. August-September. Occasional. Naturalized from Europe.