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WHITMAN LAKE WETLAND:
A FLORISTIC AND PHYTOGEOGRAPHIC ANALYSIS

presented by

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Robert K. Jones
Major professor

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WHITMAN LAKE WETLAND:
A FLORISTIC AND PHYTOGEOGRAPHIC ANALYSIS

By

Nick Alan Stoynoff

A THESIS

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ABSTRACT

WHITMAN LAKE WETLAND:
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The vegetation of the Whitman Lake wetland in Kalamazoo County, Michigan is composed of fen, southern sedge meadow, and shrub-carr communities. The fen and shrub-carr communities are well represented with the latter succeeding the former. The fen community bordering the lake is segregated into three vegetation zones.

Vegetation data from the Whitman Lake fen and ten other fens in southern Michigan were used to determine characteristic species of the fen community. Comparison of the characteristic fen species with those of other communities indicates that the fens examined are most similar to those in Ohio.

Of the 212 vascular plant species in the wetland 14 of which are Eurasian introductions, 194 are in the fen proper. Following the Pleistocene, 52.1% of the fen species appear to have migrated into Michigan from refugia to the south, 20.1% from western refugia, 17.5% from eastern refugia, and 1.0% from Alaskan refugia.

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Several years ago my parents, Bill and Mary Stoynoff, shoved me into the academic arena and there I've remained. More recently my wife, Linda, has tolerated, aided, educated, and financed a sometimes pleasant, often ornery, always chaotic husband. Hence, to these people I owe the first and most sincere, "Thank you".

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INTRODUCTION

Wetlands are often thought of by the layman as unproductive, mosquito infested areas filled with cattails and a few grasses and sedges. As a result, many small wetlands (including associated lakes) have been drained to make more land available for farms, housing developments, malls, and other such projects. In 1956 Shaw and Fredine estimated that over one-third of the original wetland area in the United States had been eliminated (Sytsma and Pippen, 1981a). This is truly an unfortunate set of circumstances when one realizes that of the 238 plant taxa in Michigan examined by Beaman (1977), slightly over 38% (91 species) are of aquatic and wetland habitats. The high species diversity within wetlands and their rapid rate of destruction emphasizes the importance of understanding the biology and geology of these areas.

The Whitman Lake wetland provides a unique opportunity for study, because the surrounding area was first settled in the mid-1800's (Durant, 1880) and extensively farmed only until 1917 (Geesy, 1941). In 1917 a large parcel of land containing this wetland was leased and eventually purchased by the federal government for a troop training site eventually called Fort Custer (Geesy, 1941). The important point is that a great deal of human influence bore upon the wetland and surrounding area for a period of 70 to 80 years, while for the last 66 years much of this influence has been eliminated. This is especially true today as the

Whitman Lake wetland lies within the confines of a buffer zone for the artillery firing range at Fort Custer.

A sizeable portion of this wetland is populated by Salix and Cornus shrubs (shrub-carr) and a small portion is dominated by sedges (sedge meadow), but much of the area is dominated by the fen community. The fen community is different from a bog in that the water is alkaline and not acid; even so, fens in Michigan do contain some typical bog taxa. The fen differs from a marsh in that the water is below, but very close to, the soil surface and not above it as is the case during most of the season in a marsh. In addition, fens have organic soils whereas marsh soils are more mineral in nature. Even in light of these differences some marsh species do occur in Michigan fens (Curtis, 1959; Pringle, 1980). The fen community differs from a swamp in that graminoids are dominant and trees play a superflous role, but again, swamp species are often found in the fen community in Michigan (Curtis, 1959; Pringle, 1980). As a result of the similarities (at least on the basis of vegetation types) and differences existing between fens and other communities, authors differ in their appraisal and definition fens. This controversy will be examined later.

The fen community of the Whitman Lake wetland has three species listed as threatened in Michigan (Wagner et al., 1977). It is not surprising that two of them, Berula erecta var. incisum and Filipendula rubra are found there, because they are both typically found in wetland habitats (Gleason and Cronquist, 1963). The third, Sporobolus heterolepis, is typically found on dry open ground (Gleason and Cronquist, 1963), illustrating the point that the vegetation of the area is a mixture of taxa from many communities and lending more credence to

Curtis' (1959) statement that a fen is a "hybrid" community. A sequence of aerial photographs available from 1938 to the present provide a qualitative illustration of vegetational changes which have occurred in the wetland during that period of time (Figures 1 and 2). At least for the present, no plans are being made to alter the status of the Whitman Lake wetland or the surrounding area (Russell[1], pers. comm.), indicating that it will continue to develop with minimal human intervention. All of these factors together illustrate that the Whitman Lake wetland provides an interesting area of study.

The fen community which surrounds Whitman Lake is generally composed of three zones of vegetation which change with distance from the lake and elevation above it; in the discussion which follows I offer a plausible explanation for that zonation. Although the fen community occupies a sizeable portion of the Whitman Lake wetland, it is not alone and the other communities present are described in the following text. In particular the "shrubby constituency" of the wetland has made large advances in terms of its areal coverage, a fact documented by aerial photographs (Figures 1 and 2).

The present study is especially important, because no other researcher has pooled data from several fens in Michigan and described species characteristic of the community. I have compiled such information for 11 fens and subsequently compared those aggregate data with data for other communities, thus determining the degree of similarity among fens in southern Michigan, Ohio, and Wisconsin, and other communities in Wisconsin.

[1]Warrant Officer Jerry Russell is the facility manager of Custer Reserve Force Training Site.

Figure 1. **Aerial photograph of the Whitman Lake wetland and surrounding area taken in 1938.**

Figure 2. Aerial photograph of the Whitman Lake wetland and surrounding area taken in 1978.

If the fen community is truly a hybrid, it is reasonable to wonder how these areas came to have such unique floras. Wisconsin glaciation played an important role in determining the nature of the present day flora of Michigan, having eliminated plant life entirely from the area during the Pleistocene. Therefore, species currently represented in Michigan must have migrated into the state from somewhere beyond the glacial margin and the distribution of species beyond the Wisconsin ice must have had some bearing upon what species are found within the fen community today. Mapping the current distribution of each species, coupled with some knowledge of the Pleistocene, allows for plausible predictions regarding the general geographic areas where Pleistocene refugia may have been located and which species may have been associates during that time period. A comparison of the phytogeographic analysis of this alkaline wetland with that of an acidic wetland, provides a unique look at the similarities and differences between the two communities.

Description of the Whitman Lake Wetland

The Whitman Lake wetland is located in section 13, Charleston Township, Kalamazoo County, Michigan. This area is a part of the Fort Custer Reserve Training Site which lies 14 miles east of Kalamazoo and five miles west of Battle Creek. Whitman Lake itself occupies some 4.5 acres (1.8 hectares) of the 60 acre (24.3 hectare) wetland, all of which lies at an elevation of approximately 880 feet above sea level (United States Geological Survey, 1972). The inlet creek flows from the southwest and the outlet creek exits to the northeast, eventually bearing northwestward and emptying into the Kalamazoo River. Numerous springs contribute a flow of water to the lake and to the inlet creek.

The wetland lies in a depression 60 to 80 feet lower than the surrounding morainal ridges. The fen community (Figures 3 and 4) is best developed in the area surrounding the lake, especially the western and northeastern shores. To the southwest is an area of sedge meadow (Figure 3) characterized by the presence of Eleocharis rostellata and several species of Carex. Throughout the entire wetland Cornus/Salix shrub-carr (Figure 3) dominates large sections of the highest areas.

The soil of the wetland is a poorly drained Houghton muck (Austin, 1979). The surrounding moraine is characterized by soils of Spinks loamy sand or Spinks-Coloma loamy sand with slope varying between 12 and 35 percent (Austin, 1979). The vegetation of the moraine is oak-hickory forest, with a variety of other species such as black cherry, black locust, flowering dogwood, and sugar maple. Transition from the dry upland forest to the wet lowland is abrupt.

History

Original land entries of people who purchased land from the government list Isaac Whitman (misspelled as "Wightman" and Whiteman" in some records) as being a purchaser in Kalamazoo County. The assessment roll of 1839 shows Isaac Whitman as owning 40 acres of land in section 13 (which includes Whitman Lake) worth $250 (Durant, 1880). From then until 1850 the census records show the presence of Isaac and/or John Whitman at that site (Durant, 1880; Kalamazoo County Assessment Rolls, 1844; Michigan Genealogical Council, 1976; McGlynn, 1977), so it is apparently from these two men that the lake received its name. The presettlement vegetation surrounding the wetland was oak forest and oak savanna (Hodler et al., 1981) and following the arrival of the first white settlers in

Figure 3. Vegetation map of the Whitman Lake wetland depicting the current distribution of communities within the study area.

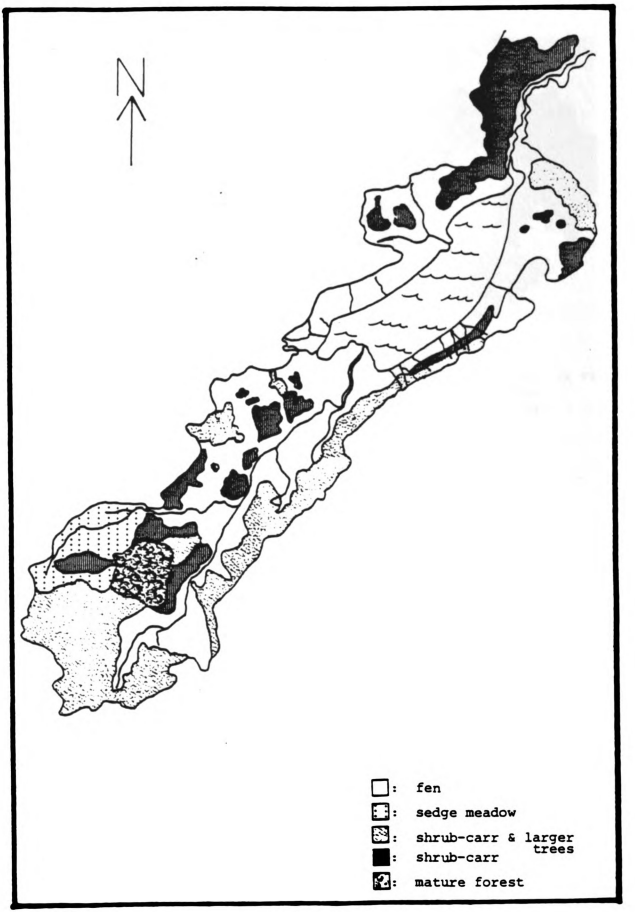
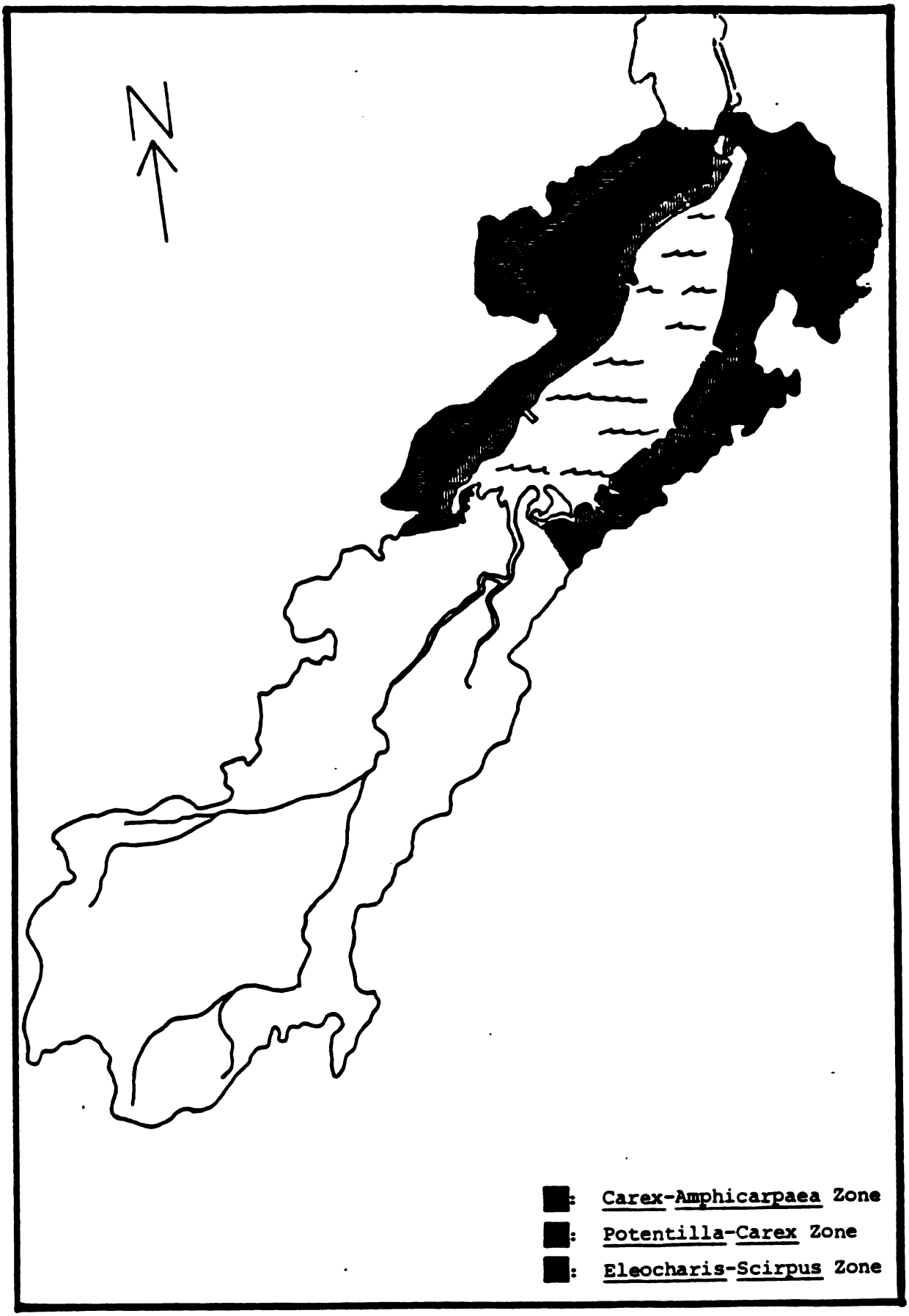

N
: fen
: sedge meadow
: shrub-carr & larger trees
: shrub-carr
: mature forest

Figure 4. Vegetation map of the Whitman Lake wetland depicting the approximate position of the three zones within the fen community surrounding the lake.


N
: Carex-Amphicarpaea Zone
: Potentilla-Carex Zone
: Eleocharis-Scirpus Zone

1828, much of the area was clear-cut for farming (Kenoyer, 1930). The original land survey notes of John Mullett (1826; Durant, 1880) describe the land of section 13 as being "hilly and second rate" and the vegetation present was forest of "hickory and black, white, and yellow oak."

During the latter part of the 1800's and early 1900's, the entire area around Charleston Township was under cultivation and the town of Harmonia occupied a site overlooking the Kalamazoo River just north of what is now Fort Custer. When war was declared in 1917 the U.S. Government issued a call for cantonment sites and Battle Creek offered Harmonia as a possible site. When the offer was accepted by the Government the land was leased by the Battle Creek Chamber of Commerce from the farmers of the area. Battle Creek then oversaw the construction of a city sufficient to house 40,000 men in part of the 10,000 acres of farmland called Camp Custer (Geesy, 1941). Following World War I most of the barracks were razed and supplies were auctioned off (Geesy, 1941), with the camp being used only for R.O.T.C. training during summer months (Geesy, 1941; Anonymous, 1982).

Congress gave the camp permanent status on July 29, 1940, renamed it Fort Custer (Geesy, 1941), and enlarged it to 14,034 acres (Anonymous, 1982). During the Korean War the fort was again activated for use. In 1964 the Government put the fort's property and buildings up for sale, with the cities of Battle Creek and Springfield annexing sections. The Fort Custer Area Recreation Park now occupies 3,000 acres of what was the western side of Fort Custer surrounding Eagle Lake and the 110th National Cemetery opened on a northwest section of the property in 1982 (Anonymous, 1982).

The remnants of Fort Custer are currently known as Custer Reserve Force Training Site and the area is leased on a five year basis by the Michigan National Guard from the federal government (Russell, pers. comm.). It appears that no farming has occurred in the area of the Whitman Lake wetland since the area was first leased in 1917. A simple observation of the aerial photograph taken in 1938 (Figure 1), in agreement with Kenoyer (1930), reveals that most of the surrounding area had been clear cut and quite probably farmed prior to 1917.

Definition of the Fen Community

A fair amount of discrepancy currently exists regarding what can or cannot be called a fen. In "Types of British Vegetation" Tansley (1911) first described the fen community as "characterized by an assemblage of over a hundred species of woody and herbaceous vascular plants, by a peat soil, and by alkaline ground water, whose level varies from a few inches below the surface of the soil in summer to a few inches above it in winter and early spring." Tansley (1939) states that "the bulk of the fen vegetation consists of plants of waterlogged soils which are, however, in no way tied to alkaline conditions, but flourish equally well in marsh or fen with neutral or somewhat acidic waters, though some 'calcicolous' species are present."

Anderson (1943) first applied the term fen in North America to a springy area near the shore of Silver Lake in Dickinson County, Iowa, an area which had been earlier described as a bog by Carter (1939). Hayden (1943), Conard (1952), and Holte and Thorne (1962) adopted Anderson's terminology, with Conard describing a fen as an area "where strongly calcareous water seeps out and an accumulation of peat and tufa builds up

an alkaline raised bog or fen." Curtis (1959) applied the term to wet and springy sites which are grass dominated, with an internal flow of calcium and magnesium bicarbonate rich water, which is also occasionally rich in calcium and magnesium sulfates.

Sjors (1961) lumped several minerotrophic peatlands of northern Ontario into various fen categories. For the northern Lake States Heinselman (1970) and Boelter and Verry (1978) lumped all minerotrophic peatlands into the fen community category. For the southern Great Lakes region Pringle (1980) describes fens as peatlands dominated by grasses and sedges with stream or ground water high in available calcium and magnesium. Still other descriptions of fens have been provided for Ohio by Gordon (1969) and Denny (1979), for Illinois by Moran (1981), and for Iowa by Van der Valk (1975, 1976).

Fens in northern Michigan, as described by Schwintzer (1978) are peatlands dominated by sedges existing on a floating mat. The shallow ground water is weakly acidic to neutral (pH range 5.7 to 7.0) with the water table remaining near the peat surface throughout the year except in instances where the mat has been grounded. Barney's Lake, Beaver Island, Michigan, is a "circum-neutral bog" of northern Michigan (Fitzgerald and Bailey, 1975) which appears to be more closely associated with fens than bogs.

In southern Michigan Kohring (1982) investigated the Bakertown fen in Berrien County defining the community as a "wetland having a continuous flow of spring water which has percolated through calcareous deposits"; with most fens having "sedges, calceophiles, and nonericaceous shrubs" depending upon the regional flora. Sytsma and Pippen (1981a, b, 1982a, b, c) have investigated the Hampton Creek wetland complex in

Kalamazoo County and defined the existing fen community in accordance with Curtis (1959). Hoffhines and Nepstad (In press) also used Curtis' definition of the community, in completing an island biogeographic analysis of 10 fens (including the Whitman Lake fen) in southwestern Michigan. Cain and Slater (1948) investigated the vegetation of Sodon Lake in Oakland County, Michigan, where the fen was composed of a mixture of graminoids, succeeded by Potentilla and Betula shrubs on a peaty soil of circumneutral reaction.

Many different characteristics of Michigan fens have been investigated and several criteria appear useful in terms of defining this community. In the present study this community seems best characterized as a wet and often springy area whose vegetation is dominated by graminoids growing in a peat soil of circum-neutral reaction. The water table is found near the peat surface and is laden with calcium and magnesium carbonates and at times sulfates. The ground water percolates through calcareous glacial till resulting in the characteristic minerotrophic nature.

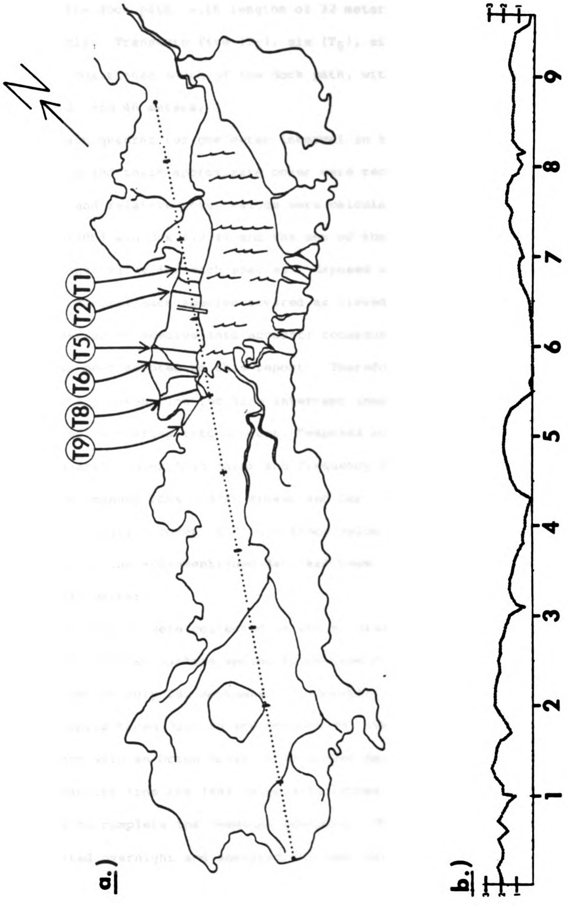
METHODS

Field studies of the Whitman Lake wetland were made from mid-June, 1982, to the beginning of June, 1983. To avoid military maneuvers, field trips were made Monday through Thursday of each week of June through September, 1982, and once or twice a month between October, 1982, and June, 1983.

Quantitative vegetational data of the area were collected during September, 1982, to facilitate identification of late flowering species (e.g., Solidago sp.). Data were collected along seven transects, using two different sampling methods (Figure 5). Sampling of the vegetation of the wetland as a whole was completed using a one quarter meter square quadrat placed at 192 randomly chosen points along the 970 meter transect. This transect was oriented 226 degrees from magnetic north.

The remaining six transects were run through the fen community along the western shore of the lake. Positions north and south of the dock path were paced off (20 paces per interval) and six were arbitrarily chosen as points for transects to be used in vegetation sampling. At each point a transect was marked out perpendicular to the lake's shore, extending from the lake's shore to the forest's edge. Vegetation data were collected along these six transects via the line intercept method to allow for more accurate documentation of the zonation of the fen community. Transect one (T_1) and transect two (T_2) were positioned north of the dock path, with lengths of 32 meters and 36 meters,

Figure 5. Illustration of transects used for vegetation sampling in the Whitman Lake wetland. a. Outline map of the Whitman Lake wetland showing the placement of the seven transects used. Dotted line represents the 970 m transect. Solid lines representing transects used for line intercept sampling are labeled (e.g., T9 = transect nine, etc.). b. Cross-sectional diagram depicting the change in elevation, relative to the surface of the lake, along the 970 m transect used for quadrat sampling. Vertical scale represents the elevation in meters.


N
T1
T2
T5
T6
T8
T9
a.)
b.)
1
2
3
4
5
6
7
8
9

north of the dock path, with lengths of 32 meters and 36 meters, respectively. Transects five (T_5), six (T_6), eight (T_8), and nine (T_9) were positioned south of the dock path, with respective lengths of 56, 57, 52, and 46 meters.

In each quadrat (or one meter interval in the line intercept data) the species and their approximate cover were recorded. Relative frequency and relative cover values were calculated as given in Brower and Zar (1980) and Cox (1974) and the sum of the two was used to obtain an importance value for each species. Exposed cover was estimated as the amount of surface each species covered as viewed from above without taking overlap of species into account; consequently, the term "exposed cover" has been adopted in this report. Therefore, the maximum total cover for any given plot (or line intercept interval) is 100%. By not taking species overlap into account, "exposed cover" and frequency data are necessarily lower than cover and frequency data collected in the traditional manner (Cox, 1974; Brower and Zar, 1980). Hence, relative frequency, relative cover, and importance value figures will, also, be lower than if the aforementioned data had been collected in the traditional manner.

Water samples were collected in 250 ml plastic bottles from ground water pits, natural surface spring flows, and from the lake's inlet and outlet creek on July 28, September 21, October 26, 1982, and June 6, 1983. Samples taken July 28 and October 26, 1982, were used to obtain pH readings with an Orion Research Ionalyzer Specific Ion Meter (Model 399A). Samples from the 1982 dates were frozen and stored until time was available to complete the chemical analysis. The 1983 samples were refrigerated overnight and analyzed the next day. Chemical analyses of

all samples were conducted using a Technicon Auto Analyzer II. Methods of analysis followed standard procedures as outlined by the United States Environmental Protection Agency (1974). The Technicon Auto Analyzer measures bicarbonate and carbonate ion concentration via color change of a buffered methyl orange indicator. The instrument analyzes water hardness by using disodium magnesium ethylenediaminetetraacetate (EDTA) to exchange magnesium for calcium and/or other metal cation, which chelates more stably with EDTA than does magnesium. Calmagite indicator forms a red-violet complex with magnesium for the colorimetric concentration determination (Technicon Instruments Corporation, 1972).

The level of the water table was monitored in 14 pits dug at arbitrarily chosen sites within each zone of fen vegetation along four of the short transects. The pits were excavated to depths of 0.5 to 0.8 meter with diameters of approximately 20 centimeters. Water table levels were determined by measuring the distance from the soil level to the surface of the water.

Soil samples were collected via the method described by Brower and Zar (1980) and were transferred to large petri plates. After the wet masses of the soil samples were determined, they were dried at 100°C for 24 hours. Dry mass was then determined for each sample and the soil moisture calculated in grams of water per 100 grams of dry soil following the methods of Brower and Zar (1980).

Distribution maps for as many species as possible were located through the use of Tralau (1969, 1972, 1973, 1974), Phillips and Stuckey (1976), and the Kew Record of Taxonomic Literature (1974, 1975a,b, 1976,

1977). Additional distribution maps referenced in recent literature were also utilized (e.g., monographs, revisions, theses).

Aerial photographs were used for construction of the vegetation maps. A false color infrared photograph taken in 1978 was obtained from the Division of Land Resource Programs, Michigan Department of Natural Resources, Lansing, Michigan. Black and white aerial photographs were obtained for the years 1950 and 1974 from the Aerial Photography Field Office of the Agricultural Stabilization and Conservation Service in Salt Lake City, Utah. The 1938 aerial photographs were purchased from the National Archives and Records Service of the General Services Administration in Washington, D.C.

RESULTS AND DISCUSSION

Climate, Geology, and Water of the Whitman Lake Wetland

The climate of the Battle Creek area is noticeably affected by Lake Michigan. The greatest fall and winter influence occurs when prevailing westerly winds sweeping across Lake Michigan result in increased cloudiness and moderated temperatures. Clearing skies, often produced by easterly and northerly winds, result in colder temperatures more common in areas further from the lake's influence. As meteorological weather conditions change, Battle Creek's climate alternates between semi-marine and continental (Strommen, 1971).

The average annual date of the last spring freeze is May 8, and the average annual date of the first autumn frost is October 9, producing an average annual growing season (frost-free period) of 154 days. During the period 1940-1969, the coldest month of the year was January with an average temperature of 23°F and the warmest month of the year was July with an average temperature of 72°F. Extreme temperatures for the Battle Creek station were recorded on February 12, 1899 (the low of -24°F) and on July 14, 1936 (the high of 104°F; Strommen, 1971).

Of the 33.9 inches of precipitation received annually, 58% falls during the May through October period. February is the driest month on average, with 1.66 inches of precipitation, and June is the wettest month, with an average precipitation of 4.01 inches (Strommen, 1971). Battle Creek, lying on the eastern fringe of the "Lake Snow Belt", has an

average annual snowfall of 44.4 inches and averages 63 days per year with one inch or more of snow on the ground (Strommen, 1971).

Whitman Lake lies within the Tekonska Moraine (Leverett and Taylor, 1915; Monahan[1], pers. comm.) in an area influenced by the Lake Michigan and Saginaw Bay lobes of the Wisconsin glacier. Apparent stagnation of the Lake Michigan lobe is marked by the series of end moraines lying just northwest of the Whitman Lake wetland (Leverett, 1912; Monahan, pers. comm.). According to Monahan, stagnation of the Lake Michigan lobe resulted in the deposition of a series of ice blocks extending from what is now Portage Lake to Hart's Lake, with subsequent advance and retreat of the Saginaw Bay lobe depositing a layer of till covering the blocks. Eventual melting of those subterranean ice blocks created a series of wetlands and kettle lakes, again, extending from Portage Lake to Hart's Lake. The interlobate location of this site makes the actual glacial activity difficult to reconstruct, but the preceding discussion is at least a possible explanation (Monahan, pers. comm.).

The till upon which the surrounding upland forest exists in the immediate Whitman Lake wetland area is a coarse sand and gravel mixture. This mixture derived from the Upper Saginaw Formation (Verne Limestone), Grand River Formation (Marshal Sandstone), Bayport Limestone, Michigan Shale, Napoleon Limestone, and Coldwater Shale (all of Carboniferous age) was deposited approximately 16,000 years B.P. by the Wisconsin ice sheet (Martin, 1936; Monahan, pers. comm.). The underlying bedrock of the area is Coldwater Shale with perhaps a thin layer of overlying sandstone.

[1]Bill Monahan, Master of Science degree candidate in the Department of Geology at Michigan State University, is completing a thesis project on the geology of Kalamazoo County, Michigan.

Depth of the till varies from 100 feet (30.5 meters) to 150 feet (45.7 meters; Monahan, pers. comm.).

Water is contributed to the area via atmospheric precipitation as described in the meteorological section and via ground water. The numerous springs, surfacing in the Carex-Amphicarpaea zone of vegetation (zones discussed in "VEGETATION" section), provided an influx of water throughout the year of this study.

The chemistry of the water samples collected is given in Table 1. The highly calcareous nature of the water samples and the existence of $CaCO_3$ precipitate in the surface springs indicates that the water may be supersaturated with carbonate. Additionally, the hardness analysis does not measure the concentration of monovalent ions which may be contributing to water hardness (see "METHODS" section of this paper). Therefore, it is not uncommon to see alkalinity values in excess of hardness values (Burton[1], pers. comm.). The pH and alkalinity values complement one another, as high levels of carbonate ions react with water molecules to form hydroxyl ions and drive the pH to neutrality and above. The high alkalinity and hardness concentrations are a result of carbonate laden glacial till being solubilized by percolating water (Wetzel, 1975), which eventually reaches the level of the water table and flows into depressions such as that of the Whitman Lake wetland. Further indication of the calcareous nature of the inflowing water is the white precipitate present within the spring flows, which effervesces upon treatment with hydrochloric acid. The minerotrophic nature of the water at Whitman Lake

[1]Dr. Thomas Burton, Associate Professor in the Departments of Zoology and Fisheries and Wildlife, Michigan State University, is currently researching the chemical nature of some water systems in Michigan.

Table 1. Mean values for chemistry of water samples from Whitman Lake wetland. (S.D. values given in parentheses)

Chemical Characteristic	Ground Water Pits	Surface Springs	Lake Inlet	Lake Outlet
pH	7.4	7.2	7.7	8.1
Alkalinity (mg $CaCo_3$/l)	289.6 (±44.1)	284.3 (±57.6)	220.8 (±21.5)	192.7 (±28.4)
Hardness (mg $CaCO_3$/l)	234.8 (±9.9)	226.3 (±17.0)	223.8 (±10.8)	206.3 (±6.4)

Table 2. Comparison of mean values for shallow ground water chemistry from various locations. (S.D. given in parentheses if published.)

Chemical Characteristic	Whitman Lake Fen	Northern Michigan Fens[a]	Northern Lake States Fens[b]	Lawrence Lake[c]
pH	7.4	6.5	4.0-8.0	7.5
Alkalinity (mg $CaCO_3$/l)	289.6 (±44.1)	153.0 (±7.4)	54.2 (±28.0)	255.5
Hardness (mg $CaCO_3$/l)	234.8 (±9.9)	154.33[d]	56.26[e]	289.4[f]

[a]From Schwintzer and Tomberlin (1982).
[b]From Boelter and Verry (1978).
[c]From Wetzel and Likens (1979).
[d]Sum of Ca and Mg values.
[e]Sum of Ca, Mg, Fe, Mn, Zn, and Al values.
[f]Sum of Ca and Mg values.

is in direct agreement with data of Sjors (1961), Heinselman (1970), Moore and Bellamy (1974), Boelter and Verry (1978), Schwintzer (1978, 1981), Pringle (1980), Schwintzer and Tomberlin, 1982), Sjors (1961), and others for the fen community.

A comparison of the shallow ground water chemistry from four different areas is provided in Table 2. Alkalinity and hardness values for Whitman Lake are considerably higher than those for northern Michigan fens and fens from the northern Lake States (northern Minnesota, Wisconsin, and Michigan). The higher alkalinity of Whitman Lake results in a pH value higher than that reported for northern Michigan fens and at the high end of the range reported for fens of the northern Lake States. The data for Lawrence Lake in Barry County, Michigan, are provided to further illustrate how these chemical characteristics of water can differ; indicating the greater accessibility of magnesium, calcium, carbonate, and other ions to the water entering the Whitman Lake and Lawrence Lake areas versus the fens further north.

Data from ground water pits were not collected on a regular day to day basis, so no absolute comparison of water table flux between the Whitman Lake fen and the data provided by Boelter and Verry (1978), Godwin (1931), or Kassas (1951) is possible. However, the data do show that the water table in the Eleocharis-Scirpus zone (see Figure 4 for arrangement of zones) averaged within 31 mm (S.E. = 4.01, n = 62) of the soil surface and averaged within 54 mm (S.E. = 6.26, n = 62) of the soil surface in the Carex-Amphicarpaea zone (i.e., the pits remained essentially full in both zones). Only in the Potentilla-Carex zone was there a fairly large distance consistently found between the water table and the soil surface ($\bar{X}$ = 132 mm; S.E. = 5.61, n = 93). The t-test

comparison of the mean water depths showed each zone to be significantly different from each other zone at the 95% confidence level (sample size ranged from 62 to 93).

It is also interesting to note that the greatest range of water table flux throughout the year was 130 mm in one pit in the Potentilla-Carex zone, which is far less than the 500 mm range reported by Kassas (1951) and the 300-500 mm range reported by Boelter and Verry (1978). I expect this zone would provide the most meaningful water table fluctuation results, if investigated more continuously in the future.

The only other information available regarding water table levels in Michigan fens is presented by Schwintzer (1978). However, those fens are found as floating mats which would rise and fall with the level of the water of the lake or stream (Gates, 1940), keeping the ground water level essentially constant. Also, Schwintzer's data were collected on only one day, making comparison with my data or that of Boelter and Verry of little value.

Diurnal changes in water table depth were documented for Chippenham Fen (Kassas, 1951) and Wicken Fen (Godwin, 1931) each near Cambridge, England. The daily fluctuations showed a periodicity which can be caused by growing vegetation pulling its water supply from ground water (White, 1932). Kassas (1951) documented "temporary and irregular changes" as being attributed to precipitation (water table rise) and water drainage (water table fall).

The data for Chippenham Fen also show a distinct seasonal variation (Kassas, 1951). During the period December through April the water table reaches a peak while the vegetation is dormant. The period May through August is marked by a dramatic (approximately 50 cm) drop in the water

table level, which coincides with rapid growth of the vegetation. The final period, September through November, is characterized by the recovery of the water table to its April level, a time period which coincides with senescence of vegetation (Kassas, 1951). In comparison, the water table of peatlands in the northern Lake States reaches a low point in late winter prior to snow melt (Boelter and Verry, 1978). Beginning in March, the snow melts and frost disappears causing the water table level to increase to a peak in May. By the middle of June the water table's rise is interrupted by high water demands of the vigorously growing vegetation and surficial water discharge, promoting a water table decline until it can be recharged the following spring (Boelter and Verry, 1978).

Soil moisture data are presented in Table 3. The soil of the Eleocharis-Scirpus zone is water saturated because of its close proximity to the water table. The Potentilla-Carex zone has a higher elevation than the previous zone and a greater average depth to the water table, hence its drier consistency. The soil of the Carex-Amphicarpaea zone in some areas (value "a") is water saturated as in the Eleocharis-Scirpus zone, a condition caused by the surface springs. This level of moisture content is not present in all areas of the Carex-Amphicarpaea zone as indicated by the "b" value for the zone. (A soil moisture value of 78.4 g/100 g dry soil was determined in an area with uncommonly coarse soil.) The t-test results for comparisons of soil moisture levels are presented in Table 4.

When considering the Eleocharis-Scirpus and Potentilla-Carex zones a correlation of elevation, soil moisture, and water table level exists (i.e., the higher the elevation, the lower the water table, and the drier

Table 3. Mean soil moisture (±S.E.) by vegetation zone. (The Carex-Amphicarpaea "a" value represents the wettest areas, whereas the "b" value is an average of all data collected in the zone.)

Vegetation Zone	Mean Soil Moisture (g H_2O per 100 g dry soil)	Number of Samples
Eleocharis-Scirpus	760.4 (±131.4)	3
Potentilla-Carex	466.1 (±22.0)	5
Carex-Amphicarpaea	a: 643.9 (±4.30)	2
	b: 364.5 (±120.7)	5

Table 4. T-test results for comparisons of soil moisture levels between zones of vegetation in the fen community. ("a" and "b" values refer to Carex-Amphicarpaea zone in Table 3.)

Zones Compared	Test Statistic	Significance Level
Eleocharis-Scirpus vs. Potentilla-Carex	2.93	95%
Potentilla-Carex vs.	4.83 a	99%
Carex-Amphicarpaea	0.83 b	not significant
Eleocharis-Scirpus vs.	0.68 a	not significant
Carex-Amphicarpaea	2.11 b	90%

the soil, see Figure 6 for representation of zones and elevation.). This relationship breaks down in the Carex-Amphicarpaea zone, because the soil of this area is often water saturated due to the closeness of the water table to the soil surface, even though it has the highest elevation. It is not surprising that the Carex-Amphicarpaea zone is extremely wet in some places, because the peat soil dams the flow of ground water causing it to rise toward the surface (Boelter and Verry, 1978) and high water table levels result in increased soil moisture (Heikurainen et al., 1964; Armstrong and Boatman, 1967; Schwintzer, 1978). Conversely, those soils along the wetland's edge which have a poor development of peat and greater portion of coarse constituency have lower moisture content.

Vegetation

The Whitman Lake wetland is composed of three major communities: sedge meadow, shrub-carr, and fen. The current distribution of each is mapped in Figure 3 and an aerial view of the wetland is provided in Figure 2.

Sedge Meadow. Classification of the southwestern section (Figure 3) of the study area as sedge meadow (as described by Curtis [1959]) is based upon observations made during the 1982 growing season, but no quantitative data were collected. The area is dominated by Eleocharis rostellata, with Agalinis paupercula, Carex hystericina, C. stricta, Equisetum sp. and Typha latifolia also being present.

Movement of water from this southwestern section is impeded by a "dam" (of unknown origin) at the northeast corner. It seems likely that the dam keeps the soil sufficiently water saturated to enhance the ability of Eleocharis rostellata to remain the dominant ground cover,

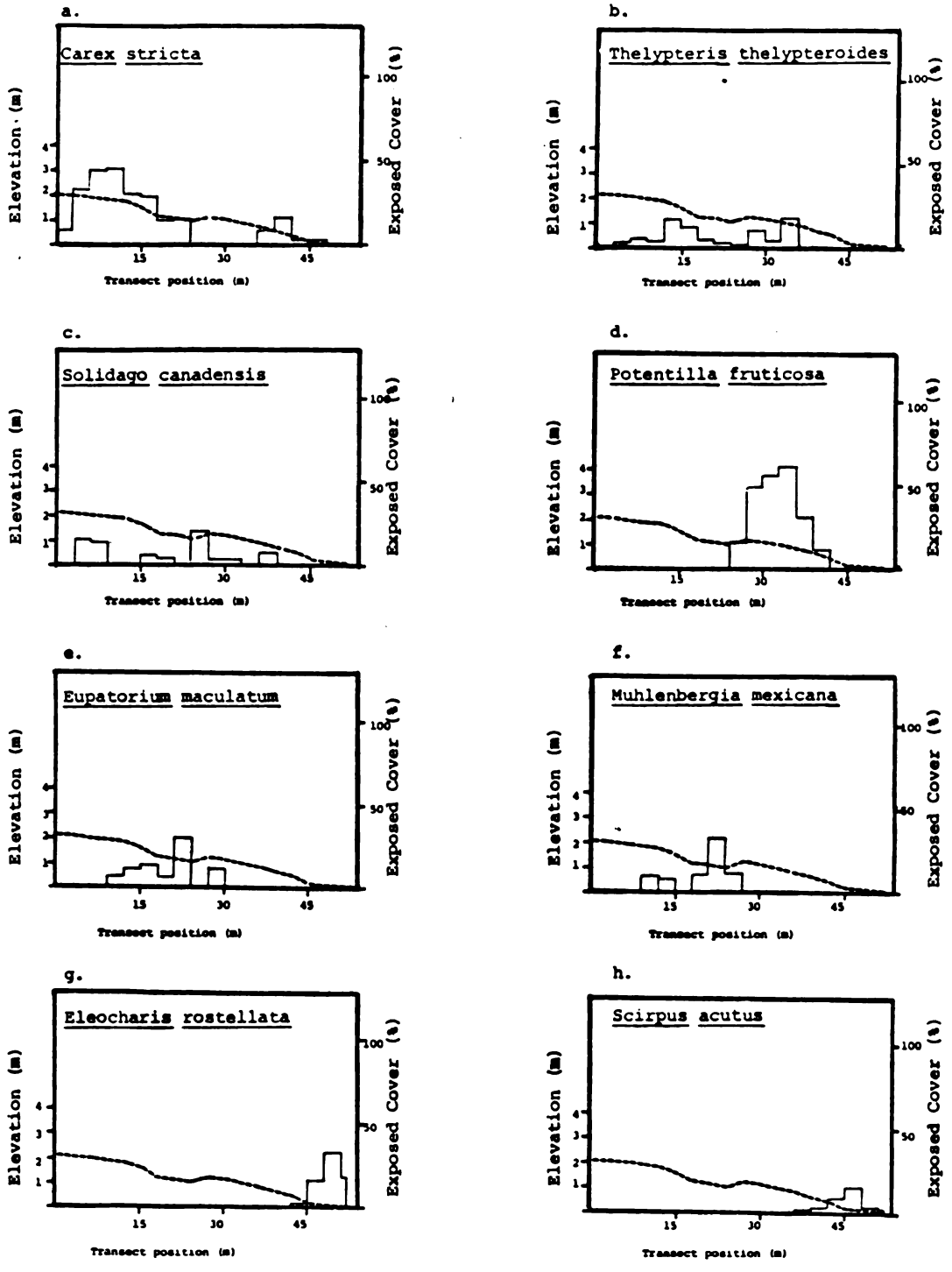


Figure 6 (a-h). Graphic representation of the distribution of eight species along transect eight (T8). Dashed line indicates elevation relative to the lake and histogram documents cover value of each species. Along this transect the Carex-Amphicarpaea zone occupies approximately meters 1-21, the Potentilla-Carex zone occupies approximately meters 22-42, and the Eleocharis-Scirpus zone occupies approximately meters 43-52.

because this species is only dominant in the wetland under such soil conditions.

Southern Shrub-Carr. A large portion of the wetland is populated by tall Cornus and Salix shrubs (Figures 2 and 3). In the areas where they are dominant herbaceous ground cover is absent or poorly developed (Table 5). This is apparently due to shading by the dense canopy.

Small areas do exist where Potentilla fruticosa and Betula pumila var. glandulifera are local dominants. Sytsma and Pippen (1981b) categorized such areas as Betula-Potentilla shrub-carr whereas Cain and Slater (1948) categorized these areas dominated by the two species as being shrub-dominated marsh which they termed Betuletum pumilae potentillosum. I have chosen to include such areas as part of the fen community discussed below.

It is interesting to note that Filipendula rubra, listed as threatened in Michigan (Wagner et al., 1977) is located as scattered individuals growing beneath the less dense shrub-carr canopy areas in the northwest corner of the study area. Flowering individuals were not observed even though this species normally flowers in June and July (Gleason and Cronquist, 1963). Failure of the species to flower may be a result of the shading effect of the Cornus canopy, but because the species is a rhizomatous perennial (Gleason and Cronquist, 1963) the few plants present may be able to survive.

Fen. The fen community is scattered through a large portion of the wetland (Figure 3) and as a whole is dominated by Carex stricta, Potentilla fruticosa, and Solidago canadensis (Table 6). This community is best developed along the shores of Whitman Lake where the assemblage of species and zonation of the vegetation is unique. Because the

Table 5. Frequency, cover, and importance values of 23 species derived from quadrat data of shrub-carr community. Only species with importance values greater than one are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Cornus foemina ssp. racemosa	68.00	54.78	84.26
Cornus stolonifera	16.00	12.82	19.76
Lindera benzoin	12.00	10.10	15.31
Carex stricta	22.00	1.91	11.18
Salix discolor	8.00	6.30	9.77
Thelypteris thelypteroides	12.00	0.70	5.75
Viburnum lentago	4.00	4.00	5.75
Cirsium muticum	10.00	0.68	4.89
Prunus serotina	4.00	2.10	3.82
Onoclea sensibilis	6.00	1.12	3.66
Aster novae-angliae	8.00	8.26	3.63
Lathyrus palustris var. myrtifolius	6.00	0.29	2.81
Aster umbellatus	6.00	0.16	2.69
Calamagrostis canadensis	6.00	0.13	2.65
Clematis virginiana	4.00	0.79	2.48
Solidago canadensis	4.00	0.36	2.05
Lycopus americanus	4.00	0.32	2.01
Thalictrum dasycarpum	4.00	0.32	2.01
Rubus strigosus	4.00	0.30	1.99
Apios americana	4.00	0.24	1.92
Filipendula rubra	4.00	0.14	1.83
Potentilla fruticosa	4.00	0.14	1.82
Solidago rugosa	4.00	0.14	1.82

*See page 21 for definition of "exposed cover".

Table 6. Frequency, cover, and importance values of 43 species derived from quadrat data of fen community. Only species with importance values greater than one are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Carex stricta	82.98	18.58	36.01
Potentilla fruticosa	39.72	8.94	17.29
Solidago canadensis	36.88	5.83	12.87
Cornus foemina spp. racemosa	23.40	3.75	8.23
Thelypteris thelypteroides	27.66	1.73	6.23
Solidago rugosa	22.70	2.03	5.90
Eupatorium maculatum	21.99	2.09	5.88
Scirpus acutus	21.28	1.96	5.61
Aster umbellatus	20.57	1.79	5.28
Pycnanthemum virginianum	21.28	1.43	4.92
Onoclea sensibilis	9.22	2.60	4.70
Muhlenbergia mexicana	21.99	1.07	4.56
Eleocharis rostellata	11.35	2.26	4.56
Apios americana	13.48	1.92	4.42
Cirsium muticum	20.57	1.08	4.36
Solidago patula	16.31	1.30	4.03
Aster novae-angliae	18.44	1.03	3.99
Solidago sp.	12.06	1.16	3.24
Eupatorium perfoliatum	14.18	0.88	3.19
Lathyrus palustris var. myrtifolius	13.48	0.29	2.32
Corylus americana	3.55	1.39	2.31
Helianthus gigantea	6.38	0.94	2.14
Monarda fistulosa	8.51	0.54	1.92
Calamagrostis canadensis	9.22	0.44	1.90
Rubus strigosus	5.67	0.82	1.88
Phalaris arundinacea	3.55	1.01	1.82
Lycopus americanus	9.22	0.22	1.61
Deschampsia cespitosa	3.55	0.84	1.59
Rhyncospora capillacea	3.55	0.82	1.57
Amphicarpaea bracteata	7.09	0.42	1.57
Aster lucidulus	7.09	0.35	1.48
Andropogon gerardii	5.67	0.49	1.45
Bromus ciliatus	8.51	0.15	1.42
Mentha arvensis	7.80	0.20	1.38
Salix discolor	5.67	0.42	1.36
Clematis viginiana	4.96	0.49	1.35
Lobelia kalmii	9.22	0.01	1.34
Scirpus americanus	7.09	0.22	1.30
Oxypolis rigidior	8.51	0.04	1.28
Angelica atropurpurea	4.96	0.40	1.24
Galium asprellum	6.38	0.22	1.20
Campanula aparinoides	7.09	0.11	1.17
Salix bebbiana	3.55	0.43	1.07

*See page 21 for definition of "exposed cover".

vegetation bordering the lake is especially characteristic of the fen community, line intercept data were gathered along six transects (Figure 5) to document the zonation and importance of the species present. Carex stricta, Potentilla fruticosa, and Eleocharis rostellata dominate this area as evidenced by the data in Table 7. The zonation of the fen vegetation surrounding the lake (Figure 4) consists of: an Eleocharis-Scirpus zone which borders the lake, a Potentilla-Carex zone lying adjacent to the first zone, and a Carex-Amphicarpaea zone between the upland forest and the Potentilla-Carex zone.

The zonation is conspicuously lacking along the south end of Whitman Lake (Figure 4). This region is dominated by Phalaris arundinacea, Solidago canadensis, and Eupatorium maculatum (pers. observ.) and extends for a distance along both sides of the inlet creek.

The Eleocharis-Scirpus zone: This zone is characterized by the dominance of Eleocharis rostellata and Scirpus acutus and the lowest species variety of the three zones (Table 8). Species characteristic of, but not necessarily dominant in this zone are: Carex leptalea, Cladium mariscoides, Eleocharis rostellata, Scirpus acutus, Lobelia kalmii, Lysimachia quadriflora, and Solidago ohioensis.

Data collected along transect eight (T8, Figures 5 and 6) provide exemplary illustrations of the vegetation and elevation changes in the fen community bordering the lake. Along this particular transect the Eleocharis-Scirpus zone occupies (approximately) meters 43 through 52. The soil is constantly water saturated due to its low elevation relative to the lake and the water table and in many instances to the wide flat flow of water from the springs as they approach the lake's margin. During no period of the year was this area completely inundated with

Table 7. Frequency, cover, and importance values of 42 species derived from line intercept data of the fen community surrounding the lake. Only species with importance values greater than 1.2 are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Carex stricta	68.46	12.85	30.14
Potentilla fruticosa	30.11	8.41	17.09
Eleocharis rostellata	24.37	6.00	12.71
Solidago canadensis	22.94	3.34	8.76
Eupatorium maculatum	17.92	3.47	8.03
Thelypteris thelypteroides	24.37	2.30	7.57
Scirpus acutus	24.37	1.34	6.24
Amphicarpaea bracteata	8.96	2.38	4.92
Solidago patula	13.98	1.65	4.81
Apios americana	13.26	1.41	4.34
Muhlenbergia mexicana	13.26	1.26	4.14
Deschampsia cespitosa	8.24	1.84	4.03
Pycnanthemum virginianum	13.62	0.97	3.79
Andropogon gerardii	12.19	0.96	3.53
Sorghastrum nutans	8.24	1.42	3.45
Solidago rugosa	8.60	1.27	3.30
Cirsium muticum	11.83	0.83	3.28
Calamagrostis canadensis	13.26	0.54	3.13
Typha latifolia	12.19	0.65	3.09
Aster lucidulus	8.96	0.91	2.87
Aster simplex var. simplex	11.11	0.55	2.76
Mentha arvensis	8.24	0.64	2.37
Eupatorium perfoliatum	6.81	0.70	2.19
Cornus stolonifera	2.15	1.23	2.10
Rubus occidentalis	3.23	1.08	2.08
Impatiens capensis	6.09	0.69	2.05
Campanula aparinoides	10.04	0.14	2.00
Scirpus americanus	8.96	0.17	1.84
Solidago ohioensis	5.02	0.67	1.84
Aster novae-angliae	6.09	0.52	1.81
Corylus americana	2.15	0.98	1.75
Monarda fistulosa	5.38	0.56	1.75
Galium asprellum	7.17	0.25	1.64
Leersia oryzoides	3.94	0.60	1.54
Bromus ciliatus	6.09	0.18	1.35
Pteridium aquilinum	3.58	0.45	1.34
Lathyrus palustris var. myrtifolius	5.38	0.25	1.32
Onoclea sensibilis	3.58	0.47	1.30
Spartina pectinata	5.73	0.18	1.28
Angelica atropurpurea	3.23	0.50	1.27
Sporobolus heterolepis	1.79	0.65	1.23
Lycopus americanus	5.02	0.23	1.22

*See page 21 for definition of "exposed cover".

Table 8. Frequency, cover, and importance values of 29 species of the Eleocharis-Scirpus zone. Only species with importance values greater than one are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Eleocharis rostellata	85.53	21.98	66.23
Scirpus acutus	69.74	4.56	25.60
Carex stricta	38.16	3.36	15.86
Potentilla fruticosa	18.42	3.57	11.78
Deschampsia cespitosa	10.53	2.29	7.28
Solidago ohioensis	13.16	1.50	6.19
Solidago canadensis	10.53	1.25	5.06
Scirpus americanus	18.42	0.33	4.90
Lobelia kalmii	18.42	0.14	4.51
Cladium mariscoides	17.11	0.28	4.50
Solidago patula	9.21	0.86	3.92
Carex leptalea	9.21	0.82	3.85
Campanula aparinoides	14.47	0.14	3.60
Phalaris arundinacea	7.89	0.82	3.54
Carex hystericina	10.53	0.30	3.05
Eupatorium maculatum	5.26	0.68	2.65
Aster simplex var. simplex	7.89	0.31	2.46
Aster novae-angliae	5.26	0.45	2.15
Solidago rugosa	5.26	0.43	2.11
Cirsium muticum	5.26	0.31	1.86
Lysimachia quadriflora	6.58	0.16	1.85
Thelypteris thelypteroides	3.95	0.40	1.75
Rudbeckia hirta	3.95	0.39	1.74
Calamagrostis canadensis	3.95	0.37	1.68
Juncus brachycephalus	5.26	0.04	1.29
Mentha arvensis	3.95	0.16	1.24
Solidago riddellii	2.63	0.29	1.22
Muhlenbergia mexicana	3.95	0.07	1.05
Rhyncospora capillacea	3.95	0.07	1.04

*See page 21 for definition of "exposed cover".

water, nor did the soil have that "springy" characteristic of a floating bog mat.

The Potentilla-Carex zone: The transition from the Eleocharis-Scirpus zone to the Potentilla-Carex zone is obvious in all areas, because the latter is characterized by the dominance of Potentilla fruticosa and Carex stricta as evidenced by their higher importance values (Table 9). Characteristic species which distinguish this zone include: Agropyron trachycaulum, Andropogon gerardii, Deschampsia cespitosa, Muhlenbergia mexicana, Phalaris arundinacea, Smilacina stellata, Sorghastrum nutans, Calystegia sepium, Lathyrus palustris var. myrtifolius, Potentilla fruticosa and Pycnanthemum virginianum. The dominance of the grasses and Potentilla fruticosa is in some areas great enough that Carex stricta becomes a minor or nonexistent component.

Along transect eight (Figure 6) the Potentilla-Carex zone approximately occupies the area from meter 22 through 42, with Potentilla fruticosa and Carex stricta being most important and Thelypteris thelypteroides, Eupatorium maculatum, and Solidago canadensis being of secondary importance. This zone is abruptly higher in elevation and has a much higher species diversity than the Eleocharis-Scirpus zone.

The Carex-Amphicarpaea zone: This third zone of fen vegetation is in some places very distinct from the Potentilla-Carex zone and in other areas the two blend into one another. Carex stricta continues to play an important role with Amphicarpaea bracteata and Apios americana becoming much more important (Table 10). Species characteristic of this zone include: Onoclea sensibilis, Carex stricta, Leersia oryzoides, Symplocampus foetidus, Amphicarpaea bracteata, Angelica atropurpurea, and Pilea pumila.

Table 9. Frequency, cover, and importance values for 36 species of the Potentilla-Carex zone. Only species with importance values greater than one are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Carex stricta	82.79	19.00	35.48
Potentilla fruticosa	53.28	16.77	28.19
Solidago canadensis	33.61	4.86	11.03
Eupatorium maculatum	22.13	4.68	9.01
Thelypteris thelypteroides	31.15	3.18	8.66
Sorghastrum nutans	18.85	3.25	6.81
Pycnanthemum virginianum	25.41	2.00	6.37
Muhlenbergia mexicana	21.31	2.19	5.95
Andropogon gerardii	21.31	1.97	5.68
Deschampsia cespitosa	12.30	2.77	5.21
Solidago patula	16.39	2.19	5.17
Apios americana	13.93	1.63	4.12
Cirsium muticum	14.75	1.20	3.75
Aster simplex var. simplex	16.39	0.87	3.61
Solidago rugosa	9.84	1.70	3.56
Monarda fistulosa	11.48	1.20	3.23
Calamagrostis canadensis	15.57	0.57	3.13
Mentha arvensis	10.66	0.94	2.79
Aster lucidulus	8.20	1.00	2.47
Aster novae-angliae	9.02	0.77	2.34
Campanula aparinoides	13.11	0.23	2.33
Spartina pectinata	11.48	0.39	2.27
Bromus ciliatus	11.48	0.37	2.25
Scirpus acutus	12.30	0.21	2.19
Lathyrus palustris var. myrtifolius	9.84	0.52	2.16
Typha latifolia	9.84	0.38	2.00
Lycopus americanus	9.02	0.47	1.97
Eupatorium perfoliatum	6.56	0.73	1.90
Carya glabra	4.92	0.71	1.62
Scirpus americanus	7.34	0.17	1.36
Galium asprellum	7.38	0.15	1.34
Calystegia sepium	5.74	0.34	1.31
Solidago ohioensis	3.28	0.61	1.23
Cornus stolonifera	1.64	0.81	1.22
Solidago sp.	3.28	0.49	1.09
Angelica atropurpurea	2.46	0.52	1.00

*See page 21 for definition of "exposed cover".

Table 10. Frequency, cover, and importance values for 39 species of the Carex-Amphicarpaea zone. Only species with importance values greater than one are listed.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Carex stricta	75.31	12.48	30.04
Amphicarpaea bracteata	27.16	8.01	15.43
Eupatorium maculatum	23.46	4.25	9.83
Thelypteris thelypteroides	33.33	2.74	9.65
Apios americana	24.69	2.40	7.64
Solidago canadensis	18.52	3.01	7.31
Typha latifolia	27.16	1.66	7.12
Rubus occidentalis	11.11	3.71	6.88
Impatiens capensis	18.52	2.08	6.09
Corylus americana	7.41	3.38	5.78
Leersia oryzoides	13.58	2.06	5.16
Aster lucidulus	16.05	1.52	4.91
Cornus stolonifera	4.94	3.02	4.86
Solidago patula	14.81	1.59	4.77
Calamagrostis canadensis	18.52	0.65	4.22
Onoclea sensibilis	11.11	1.55	4.05
Pteridium aquilinum	9.88	1.51	3.78
Cornus foemina ssp. racemosa	3.70	2.28	3.66
Solidago rugosa	9.88	1.39	3.62
Eupatorium perfoliatum	11.11	1.13	3.50
Cirsium muticum	13.58	0.75	3.45
Galium asprellum	13.58	0.64	3.30
Muhlenbergia mexicana	9.88	0.98	3.08
Angelica atropurpurea	7.41	0.94	2.58
Pilea pumila	7.41	0.94	2.58
Sporobolus heterolepis	3.70	1.44	2.56
Mentha arvensis	8.64	0.64	2.41
Boehmeria cylindrica	6.17	0.88	2.28
Andropogon gerardii	9.88	0.35	2.26
Solanum dulcamara	7.41	0.67	2.22
Prunus serotina	2.47	1.29	2.14
Pycnanthemum virginianum	8.64	0.32	1.99
Cornus florida	1.23	1.23	1.84
Ulmus americana	1.23	1.23	1.84
Potentilla fruticosa	6.17	0.38	1.62
Calystegia sepium	6.17	0.36	1.60
Aster simplex var. simplex	6.17	0.28	1.50
Salix discolor	2.47	0.53	1.14
Asclepias syriaca	2.47	0.44	1.02

*See page 21 for definition of "exposed cover".

Sporobolus heterolepis (Prairie dropseed) reaches its highest importance along T9 (see Tables 10 and 11). This species, listed as threatened in Michigan (Wagner et al., 1977), is growing in small dense isolated stands on the tops of some ant mounds. Growth on top of these mounds provides improved soil drainage, soil aeration, and soil fertility (Wali and Kannowski, 1975), perhaps explaining why it grows where it does. Additionally, "collection wounds" have taught me that the ants tolerate little disturbance and may play some role in repelling herbivores.

Transect eight (Figure 6) illustrates that the Carex-Amphicarpaea zone is highest in elevation, occupying approximately the first 21 meters of the transect. Along transect eight Carex stricta, Thelypteris thelypteroides, and Solidago canadensis are three important species (Figure 6 a, b, and c), but the important species in this zone vary from transect to transect as evidenced by Table 11.

Data from Table 11 show that not only do the cover, frequency, and importance value determinations for the six transects differ, but also the species composition. It is curious to have species characteristic of ultra-wet soils (e.g., Leersia oryzoides, Typha latifolia, Impatiens capensis, and Pilea pumila) and species characteristic of dry soils (e.g., Pteridium aquilinum, Sorghastrum nutans, Sporobolus heterolepis, and Corylus americana) having comparable importance values within the same zone of vegetation. These data illustrate the heterogeneous nature of the Carex-Amphicarpaea zone.

A conclusive explanation of the heterogeneity of the Carex-Amphicarpaea zone and the general zonation of vegetation within the fen is beyond the scope of this research, but a possible explanation is

Table 11. A comparison of the frequency, cover, and importance values of the most important species in the Carex-Amphicarpaea zone along each of the six transects through the fen community surrounding the lake.

Species	Frequency (%)	Exposed* Cover (%)	Importance Value
Transect 1			
Corylus americana	50.00	22.83	40.90
Carex stricta	83.33	8.19	27.33
Pteridium aquilinum	66.67	10.21	26.86
Solidago canadensis	41.67	10.42	22.31
Eupatorium maculatum	41.67	7.42	18.21
Amphicarpaea bracteata	33.33	5.02	13.31
Apios americana	41.67	3.13	12.34
Transect 2			
Cornus stolonifera	33.33	20.00	27.58
Eupatorium perfoliatum	83.33	8.92	24.38
Carex stricta	83.33	8.25	23.66
Prunus serotina	16.67	16.67	21.02
Ulmus americana	16.67	16.67	21.02
Eupatorium maculatum	33.33	6.17	12.57
Thelypteris thelypteroides	50.00	3.08	12.17
Typha latifolia	50.00	1.50	10.45
Transect 5			
Amphicarpaea bracteata	76.19	27.60	48.42
Carex stricta	61.90	4.22	16.99
Apios americana	47.62	5.03	15.26
Cornus foemina ssp. racemosa	14.29	8.81	13.54
Onoclea sensibilis	23.81	4.57	10.16
Transect 6			
Leersia oryzoides	83.33	13.71	43.14
Impatiens capensis	83.33	11.63	39.51
Carex stricta	58.33	10.21	31.27
Pilea pumila	33.33	5.50	17.29
Solanum dulcamara	41.67	4.25	17.03
Solidago patula	25.00	3.25	11.44
Transect 8			
Carex stricta	95.24	29.49	51.82
Thelypteris thelypteroides	66.67	5.38	17.07
Solidago canadensis	38.10	5.12	12.33
Aster lucidulus	42.86	4.43	12.19
Eupatorium maculatum	33.33	5.19	11.68
Transect 9			
Rubus occidentalis	55.56	28.28	46.63
Solidago rugosa	97.78	10.00	26.75
Sporobolus heterolepis	33.33	12.94	22.74
Thelypteris thelypteroides	55.56	6.28	17.98
Carex stricta	66.67	3.61	16.47
Onoclea sensibilis	44.44	3.28	12.11

*See page 21 for definition of "exposed cover".

proposed below. Armstrong and Boatman (1967) found that in soils oxygenated by water turbulence Molinia grew vigorously, but with stagnation of the water flow (decreased turbulence and oxygenation) Molinia growth decreased markedly until its disappearance from soils under extreme reducing conditions. Collins et al. (1979, 1982) reported that dredging of streams in Champaign County, Ohio, resulted in a lowered water table in a nearby fen. Earlier floristic studies of that fen do not show Thuja occidentalis as being present, but the species now appears to be establishing itself such that an arbor vitae forest may well be replacing the existing herb dominated fen. Schwintzer (1979) reported increased tree mortality in a bog where high water levels raised the water table to within a few centimeters of the mat surface. Increased soil moisture and decreased soil aeration are the result of high water table levels (Armstrong and Boatman, 1967; Heikurainen et al., 1964; Schwintzer, 1979).

It is reasonable, then, to expect that soil aeration (or lack of it) as a function of water table level and soil moisture contributes significantly to plant distribution in the Whitman Lake fen and wetland in general. Significant areas of shrub-carr, whether they be Viburnum, Salix, or Cornus dominated, are found only on the areas of highest elevation (i.e. - those areas where a sufficient uppermost layer of aerated soil is present). In addition to the shrub-carr, those species which characterize the Potentilla-Carex zone seem to be favored by more highly aerated soil and are most common on the higher, better-drained soils. That is not to say Salix, Potentilla, or others are never found in the more heavily water-laden soils, but that they are much less common there. In contrast, Eleocharis rostellata, Scirpus acutus and other

species flourish in the water saturated soil of the sedge meadow and/or lake margin. These species are not necessarily obligated to such soil conditions, but appear to be more tolerant of them.

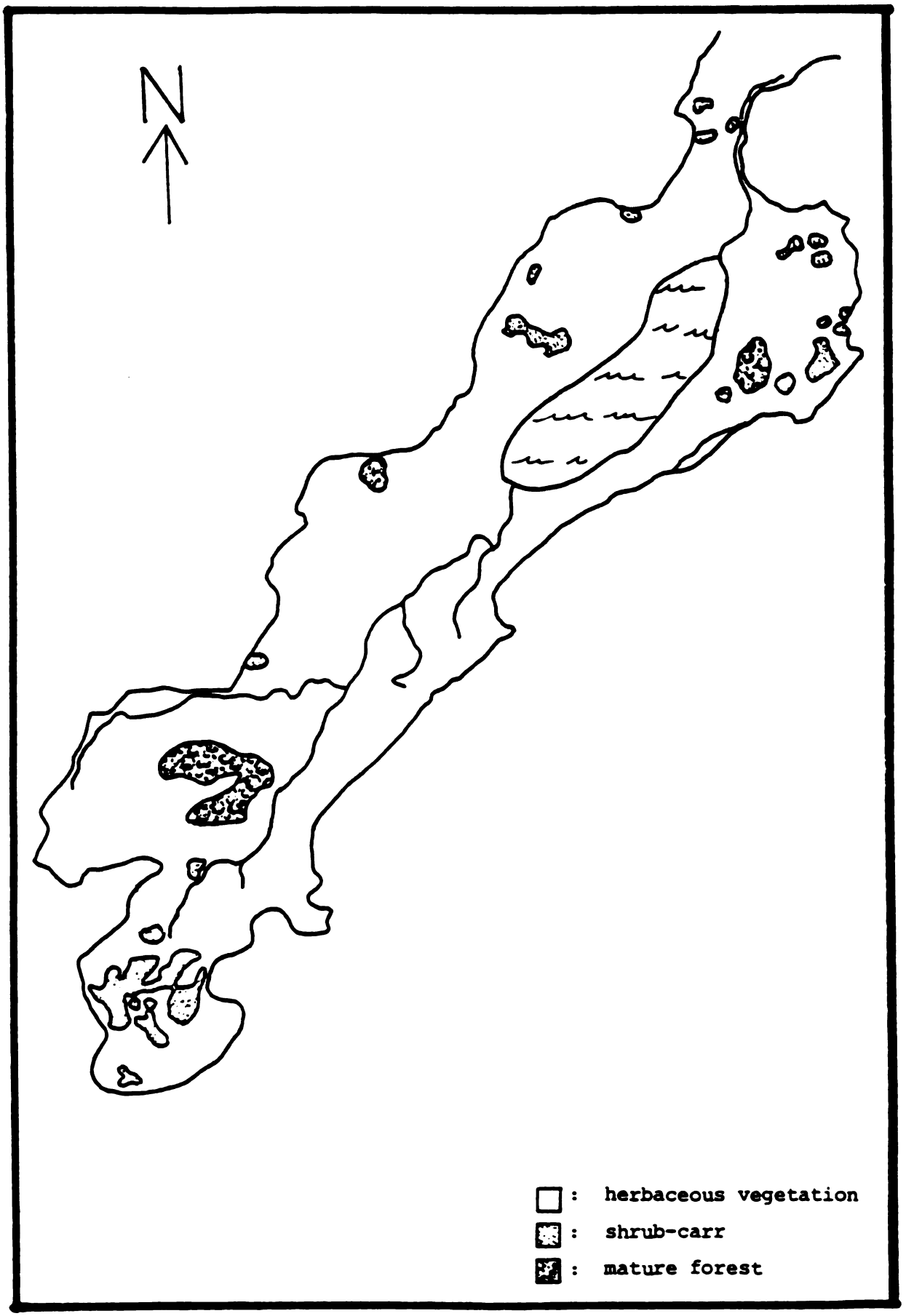
This scenario must certainly play an important role in controlling the vegetation of the Carex-Amphicarpaea zone. Just as certainly, however, soil texture, competition, shading by the forest canopy, and probably other factors contribute to the vegetational heterogeneity of the Carex-Amphicarpaea zone, to the zonation of the fen vegetation, and to the heterogeneity of the entire wetland.

Historical Changes in Vegetation. One of the most dramatic changes which has occurred in the Whitman Lake wetland is evidenced by comparison of the two aerial photographs (Figures 1 and 2) and the vegetation maps derived from aerial photographs (Figures 3 and 7). A tremendous increase in the amount of area covered by the shrub-carr community has occurred in the 45 year time span since the first photo was taken.

The subject of fen succession has been thoroughly discussed by Curtis (1959) and Sytsma and Pippen (1982b), where two trends in development are proposed. One is characterized by the encroachment of wet northern forest into fen areas where the soil is water saturated throughout the growing season (Sytsma and Pippen, 1982b). In this scenario Larix laricina successfully invades emergent aquatic and wet fen communities, eventually to be succeeded by southern hardwood forest if the degree of disturbance is sufficiently low. However, the cases are rare where little disturbance occurs in a Tamarack forest, hence Tamarack generally replaces itself (Sytsma and Pippen, 1982a).

Larix is found at the south edge of the sedge meadow community, but is poorly represented (i.e., only one large tree of approximately 15

Figure 7. Vegetation map of the Whitman Lake wetland depicting the distribution of communities within the study in 1938.


N
: herbaceous vegetation
: shrub-carr
: mature forest

meters in height and 6 - 10 small trees of 1 - 2 meters in height are present). It is either just beginning to invade or has been present for quite some time and cannot become widely established in the wetland. At any rate, succession of the wetland into a wet northern forest is not currently occurring at a rapid rate, if at all.

The second successional sequence occurs with the increased build up of peat. In this instance the soil surface is eventually isolated from the ground water (i.e., the soil becomes drier) and is quickly invaded by shrub-carr. This may then be replaced by deciduous forest depending upon the stability of the shrub-carr community (Sytsma and Pippen, 1982b).

Again, judging from the aerial photographs of the Whitman Lake wetland, Cornus/Salix shrub-carr has replaced much of the formerly herbaceous ground cover. As was indicated earlier, in areas where springs are not surfacing, the depth to the water table varies inversely with the elevation of the soil relative to the lake. In other words the higher the ground, the farther the soil surface is from the water table. It is in just such high areas that the shrub-carr community is becoming best established (Figure 5). In addition to the Salix and Cornus species, Acer rubrum, Populus tremula ssp. tremuloides, and Ulmus americana are becoming established in the areas where the surface of the soil appears to be most isolated from the ground water. Therefore, it appears that without some disturbance, the shrub-carr community will continue to succeed many of the drier soil areas in the wetland.

Comparison of Southern Michigan Fens with Other Communities. The species list for the Whitman Lake fen used in conjunction with those produced by Cain and Slater (1948), Hoffhines and Nepstad (In press), and Sytsma and Pippen (1982c) provide documentation of the species present in

11 fens in southern Michigan (the work of Kohring [1982] is conspicuously missing from this analysis, as it is difficult to be certain which species are found within the fen sections of that study area).

Curtis (1959) used species density (average number of species per stand) to choose the prevalent species of a community, a method which produces a species density of 75 for the 11 fens included from southern Michigan. The total number of species within the Whitman Lake fen is 194 and in the Hampton Creek fen is 135 (Sytsma and Pippen, 1982c), while the maximum for the other fens is 71. Since the species density for these other fens considered alone is 55, it is the high species diversity at Whitman Lake and Hampton Creek which has skewed the species density for the community upward. Therefore, I have chosen to define prevalent species as those whose presence value exceeds 50% (Table 12).

Table 13 lists the indices of similarity for the 11 southern Michigan fens relative to other fens and relative to other communities in general (data for Ohio fens from Stuckey and Denny [1981], for northern Michigan fens from Schwintzer [1978], and for all other communities from Curtis [1959]). The index in each case was calculated using the prevalent species (as defined in the preceding paragraph) for each community and the formula (Curtis, 1959):

Index of similarity = $2w/a+b$

where:

w = no. of species common to both communities

a = no. of species in community A.

b = no. of species in community B.

Table 12. Prevalent species in 11 fens in southern Michigan. Only species with a greater than 50% presence are listed.

Species	% Presence	No. of fen occurrences
Eupatorium maculatum	100	11
Eupatorium perfoliatum*	100	11
Thelypteris thelypteroides	100	11
Carex stricta	90.9	10
Rudbeckia hirta	90.9	10
Solidago ohioensis	90.9	10
Solidago patula	90.9	10
Solidago riddellii*	90.9	10
Typha latifolia	90.9	10
Cirsium muticum	81.8	9
Cornus stolonifera	81.8	9
Lobelia kalmii*	81.8	9
Lysimachia quadriflora*	81.8	9
Oxypolis rigidior	81.8	9
Pedicularis lanceolata*	81.8	9
Potentilla fruticosa*	81.8	9
Bromus ciliatus	72.7	8
Calamagrostis canadensis*	72.7	8
Galium boreale*	72.7	8
Helianthus giganteus	72.7	8
Lathyrus palustris	72.7	8
Pycnanthemum virginianum	72.7	8
Solidago graminifolia	72.7	8
Solidago canadensis	72.7	8
Asclepias incarnata*	63.7	7
Aster novae-angliae	63.7	7
Gentianopsis virgata*	63.7	7
Lycopus americanus*	63.7	7
Parnassia glauca*	63.7	7
Solidago uliginosa	63.7	7
Sorghastrum nutans	63.7	7
Andropogon gerardii	54.5	6
Aster puniceus	54.5	6
Aster simplex*	54.5	6
Caltha palustris	54.5	6
Carex sterilis	54.5	6
Chelone glabra	54.5	6
Impatiens capensis	54.5	6
Lobelia siphilitica*	54.5	6
Muhlenbergia glomerata	54.5	6
Onoclea sensibilis	54.5	6
Scirpus acutus	54.5	6
Solidago rugosa	54.5	6
Tofieldia glutinosa	54.5	6
Toxicodendron vernix	54.5	6
Thalictrum dasycarpum*	54.5	6

*Those species which are models according to Curtis (1959).

Table 13. Index of similarity between various communities expressed as a percent. Species with a presence value of 50% or greater were included. (SMF = southern Michigan fens, OF = Ohio fen, WF = Wisconsin fens, NMF = northern Michigan fens, SSM = southern sedge meadow, SC = shrub-carr, WP = wet prairie, NSM = northern sedge meadow, AT = alder thicket, BOG = bog).

SMF	OF	WF	NMF	SSM	SC	WP	NSM	AT	BOG
53									
41	26								
4	14	11							
28	8	51	11						
27	7	42	10	51					
28	20	45	4	31	16				
20	15	34	22	40	51	18			
25	14	37	13	34	48	31	54		
0	4	0	24	0	0	0	0	0	

Indices of similarity show that the 11 fens in southern Michigan have a greater degree of similarity with fens in Ohio than those examined by Curtis (1959) in Wisconsin. Curtis (1959) indicated that fens are most closely related to wet prairies and southern sedge meadows, yet the data of Table 13 indicate a near equal degree of similarity between the fen community and the southern sedge meadow, shrub-carr, wet prairie, and alder-thicket. These data imply that the fen is less similar to any one other community (in contrast to Curtis' contention), because it occupies a position in a community continuum (sensu Whittaker, 1975), whereby it is equally similar to several communities.

Curtis (1959) calculated a homogeneity index for each community by "comparing the sum of presence of the prevalent species with the total sum of presence of all species" expressed as a percentage. Using this method the homogeneity index for the 11 southern Michigan fens included is 48.1%, a figure considerably lower than the 61.3% calculated by Curtis for Wisconsin fens. This analysis illustrates the high degree of dissimilarity with respect to species presence in the Michigan fens examined versus the greater homogeneity of fens of Wisconsin.

Phytogeography

In order to come to a better understanding of the current geographic distributions and affinities of the flora of the Whitman Lake area one must take into account Michigan's icy past. Researchers place the beginning of the Pleistocene at 2,000,000 years B.P. (Davis, 1976). During the period of time from then to the present, continental ice sheets have alternately advanced and retreated from centers in Canada and obliterated the vegetation of parts of Canada and large areas of the

northern United States (Flint, 1957; Dorr and Eschman, 1971). Anywhere from four to possibly 16 glacial advance and retreat cycles occurred during the Pleistocene (Davis, 1976), with the Wisconsin glaciation beginning 100,000 years B.P. in eastern Canada and reaching a maximum 18-20,000 years B.P. (Wright, 1976; Delcourt and Delcourt, 1981). Those glacial advances which eliminated the preexisting flora, in large part dictate the current distribution (and geographic affinities) of each species within the glaciated portion of North America.

In general, two schools of thought regarding the full-glacial distribution of plants south of the glacial boundary exist. The first school, championed by E. Lucy Braun, proposes that only periglacial regions (i.e., within a few kilometers of the glacial front) suffered from harsh conditions. Boreal elements retreated southward in front of the glacier, ultimately forming a narrow band of vegetation between (and intermingling with) the deciduous forest and a narrow tundra with parkland association immediately adjacent to the glacial front. In addition, boreal species could have survived on high altitude peaks of the Appalachians as do some species of Picea and Abies today. The vegetation of the unglaciated southeast was not subjected to any large scale climatic change and therefore, distribution of the vegetation in the Pleistocene differed little from that of the present (Braun, 1950, 1951, 1955).

A variety of microclimatic conditions exist in rugged areas of the Appalachian Mountains providing refuge for outlier populations of species of more northerly or more southerly latitudes (Wolfe, 1951). Similarly, such areas could have served as refugia for northern species in more southern regions (or vice versa for more southerly plants) during

full-glacial periods and as distribution centers for species capable of colonizing newly exposed habitats following glacial retreats (Braun, 1951; Wolfe, 1951).

Many taxa restricted to previously glaciated areas of eastern North America are of western geographic affinity. Their current distribution pattern is indicative of their inability to invade the areas south of the glacial margin. That is to say that the vegetation south of the Wisconsin ice sheet (and probably others) was so minimally affected during glaciation that the eastern deciduous forests and other associated communities remained "closed" and were unavailable for colonization by western elements (Iltis, 1965, 1966).

The Two Creeks forest bed of eastern Wisconsin provides evidence of a lack of forest displacement away from the ice sheet. The southwest orientation and "shredded" character of the ends of stumps buried within the formation indicate living individuals were actually overrun by the glacial ice sheet. That is, forest and not tundra occupied the terrain adjacent to the ice front (Braun, 1955).

In a few lakes of southern Illinois (approximately 60 miles from glacial maximum) pollen and macrofossil specimens are present, providing a continuous vegetation record in sedimentary layers from the late-Illinoian glacial period to the present. Eberhard Gruger's (1970, 1972) research on these lake sediments shows a dominance of "thermophilous deciduous trees" and high percentages of herbs in the pollen record of the Wisconsin full-glacial period. His work indicates that neither tundra nor boreal forest existed south of the glacial border. Instead a mosaic of open communities, Quercus dominated

deciduous forest, and spruce/pine dominated forest communities dotted the landscape during the full-glacial period (Whitehead, 1973).

The opposing viewpoint was initiated by Deevey (1949) stating the climate south of the glacial boundary was significantly altered such that boreal vegetation inundated the southern states and essentially eliminated the mixed mesophytic deciduous forest species from those areas. These mesic deciduous forest species, thus, survived the Pleistocene in refugia which have yet to be identified with absolute certainty (Davis, 1976).

A plethora of research papers has been published in support and clarification of Deevey's hypothesis with Delcourt and Delcourt (1981) providing the most illustrative support, because of their synthesis of a series of paleo-vegetation maps based on current paleobotanical and palynological literature. Figure 8 is a representation of their paleovegetation map for the Wisconsin glacial maximum. In the following paragraphs I will briefly discuss the Delcourt's 18,000 years B.P. map (Figure 8) and introduce a few of the papers which support their contentions.

At the glacial margin and up to 60 miles south of it, lies an area of tundra, while alpine tundra is found at higher elevations extending through the Appalachians into North Carolina and Tennessee (Maxwell and Davis, 1972; Delcourt and Delcourt, 1981). Areas south of the glacial border still bear signs of "intense frost action" (Flint, 1957) indicating the presence of tundra in a 50 to 100 mile wide swath adjacent to the glacial margin (Martin, 1958). Late-glacial pollen assemblages from New England are herb dominated (Davis, 1965), most similar to those produced today in tundra regions far from forested areas. In contrast,

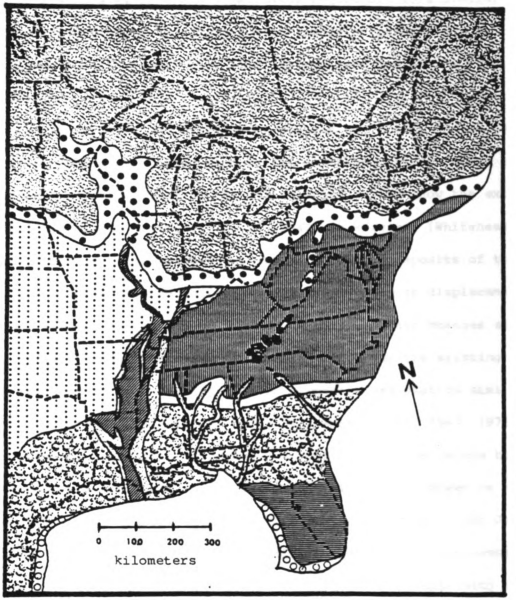


Figure 8. Paleovegetation map depicting the distribution of forests in eastern North America during the Wisconsin glacial maximum (adapted from Delcourt and Delcourt, 1981).

- Ice sheet
- Tundra
- Spruce-Jack Pine Forest
- Jack Pine Forest
- White Spruce Forest
- Mixed Conifer and Northern Hardwood Forest
- Oak-Hickory-Southern Pine Forest
- Mixed Hardwood Forest
- Sand Dune Scrub
- Cypress-Gum Forest

pollen assemblages from the Great Lakes region are more similar to those regions bordering the northern forest limits or perhaps a more parkland landscape (Davis, 1965, 1967, 1978; Maxwell and Davis, 1972; Whitehead, 1973).

A forest most like that of the present day boreal forest is mapped as having occupied a broad band as far south as northern Texas and Georgia. Deposits dated to the full-glacial period show the existence of a spruce dominated community in southeastern Virginia (Whitehead, 1965, 1967). Similarly in southeastern North Carolina, deposits of the same age are of pine savanna character, indicating a major displacement of boreal species to the south, suggesting that climatic changes south of the glacial border were significant. In each case the existing community was replaced in late glacial time by a species association similar to the northern hardwood association today (Whitehead, 1965, 1967, 1973), this suggests the presence of a hardwood association bordering the boreal-type forest on the south and lying east of the Mississippi River as mapped in Figure 8. Full-glacial sediments from two ponds in northwest Georgia yielded palynological and macrofossil data showing the dominance of pine, mixed with some aquatics and spruce. Coupling these data with the current New England, Great Lakes, and more northerly distribution of the taxa makes it apparent that a mass migration of species into the formerly glaciated northeast occurred (Watts, 1970; Whitehead, 1973).

Following the full-glacial period, climatic warming and the accompanying glacial retreat allowed various species to advance northward. Succeeding the boreal-like forest in northwestern Georgia was an association dominated by oaks, hickories, and a variety of pines, indicating that the southern coastal plain was populated by an

oak-hickory-southern pine forest during the full-glacial period (Watts, 1970; Delcourt and Delcourt, 1981).

Accompanying the advance of the continental ice sheet was a lowering of sea level of some 90 meters (Flint, 1957), which according to W.A. Watts (Wright, 1976), resulted in the water table of peninsular Florida being lowered by 60 meters. This region was then populated by Ceratiola (rosemary) and isolated scrub oak stands, producing a xeric sand dune scrub (Wright, 1976; Delcourt and Delcourt, 1981). Composed of cypress and gum trees, small regions of southern swamp forest existed along the Gulf Coast and may also have occupied other poorly-drained bottomland areas near the Gulf Coast (Delcourt and Delcourt, 1981).

The distribution of the mixed mesophytic forest is perhaps the most controversial subject. As mapped in Figure 8, Delcourt and Delcourt (1981) have shown this forest surviving the glacial maximum in ravines, along bluffs, and other rugged terrain in the south along major waterways. The Blufflands along the southern Mississippi River were proposed as a likely refugium for mixed mesophytic forest. According to Delcourt and Delcourt (1975), glacial melt water and its accompanying cold air mass were channeled down the Mississippi Valley. Contact of these two cold air sources with the relatively warmer air in the south produced extensive fogs which blanketed the Blufflands. These conditions promoted a cooler, moister climate and promoted migration of the species of the mixed mesophytic forest into the region (Delcourt and Delcourt, 1975). A Pine Barrens refugium in New Jersey (Potzger, 1946) and a "Gulf Coast" refugium (Whitehead, 1973) have also been proposed, however, no absolute locations for the glacial maximum refugia of the mixed

mesophytic forest have been pinpointed (Maxwell and Davis, 1972; Davis, 1976; Wright, 1976).

In the preceding paragraphs I have presented some of the information available in support of each of the two schools of thought regarding the distribution and composition of the forest south of the glacial margin in eastern North America during the glacial maximum. Though a preponderance of current literature on the subject supports Deevey's viewpoint (or at least a modified version of it), Wright (1976) points out some problems. Advances of some glacier lobes occurred when adjacent lobes retreated, that is to say not all advances were climatically controlled. Lake sediments in Minnesota, in a region subjected to three ice lobe advance-retreat cycles, show no pollen changes indicative of a dramatic change in climate, a fact which lends credence to a nonclimatically controlled glacial surge or current methods of pollen analysis lack sufficient sensitivity to detect climatic changes needed to document glacial fluctuations (Wright, 1976). The boreal-like forest throughout the Appalachians and into Minnesota was replaced from the south by deciduous forest between 10,000 and 12,000 years ago - a very fast turnover for such a large forest (700 miles north to south). The changing climate was affecting plant distributions, but it is important to recall that each species reacts uniquely (in terms of migration rates, ecological tolerances, etc.) to varying conditions. In summary, eastern North America was populated by a dynamic, not static vegetation and this dynamic nature, coupled with the incomplete and often unclear palynology of eastern North America, makes it difficult to paint an accurate paleoclimatic picture (Cushing, 1965; Wright, 1976). In other words, a number of studies yield an accurate record of what pollen was preserved

in a particular locality, but interpretation of that pollen record may be, and often is, a very complex, difficult undertaking.

In the following phytogeographic analysis my intent is to categorize species according to their current North American distribution and suggest possible post-Pleistocene migration routes for those species. Throughout this analysis the current distribution of each taxon is assumed to be indicative of its post-Pleistocene migration route. Contrasting the phytogeography of the Whitman Lake fen with that of Pennfield Bog (Crow, 1968) provides a unique comparison of the two floras. For ease of comparison, the species occurring in the Whitman Lake area have been separated into essentially the same groups used by Crow (1968). The five patterns of distribution used by Crow are: "1) widespread species, occurring throughout much of the United States and adjacent Canada and often widespread in other parts of the world; 2) those occurring primarily in the eastern half of the United States and adjacent Canada; 3) northeastern North America and also on the coastal plain; 4) those of northeastern North America, primarily north of the glacial boundary; and 5) northern, chiefly circumboreal species." In addition, those five categories have been subdivided and two new categories, central species and southeastern species, have been added.

Information gleaned from current literature provided clear-cut geographic distributions for many species and many of these fall nicely into Crow's categories. Other species have vaguely described ranges and/or have distributions which do not lend themselves to pigeon-holing. These problems are discussed throughout the following pages of text. Introduced species have been conspicuously omitted from this analysis.

Maps illustrating several different distribution patterns are provided. Dots arranged in a strict orderly pattern indicate an area of essentially continuous distribution. All other dots approximate specific collection localities. The solid line delineates the confirmed range of the species and a dashed line marks the extent of the species' range implied in available literature. Literature used to compile the distribution patterns is cited with each taxon in the "Vascular Plants of the Whitman Lake Wetland" section.

Species With Widespread Distribution. As stated earlier, species distributed generally throughout the United States, adjacent Canada, and in some instances into Mexico are included in this category. Of the fen species 18 (9.3%) have this widespread distribution typified by Typha latifolia (Figure 9). Other species falling in this category include: Cyperus rivularis, C. strigosus, Eleocharis rostellata, Elymus virginicus, Glyceria striata, Leersia oryzoides, Lemna minor, Sagittaria latifolia, Scirpus americanus, Sphenopholis obtusada var. major, Berula erecta var. incissum, Galium aparine, and Verbena hastata. Apparently this group of species survived the Pleistocene "somewhere" beyond the glacial boundary and each migrated in a wide generally northward direction as the glacier retreated.

Another group of species which fall into this category are not quite as widely distributed as the preceding group, as they are absent in southeastern north America. This distribution is typified by Equisetum laevigatum (Figure 10). Other species within this group include: Carex hystericina, Scirpus acutus, and Polygonum amphibium var. stipulaceum. Although little can be said to pinpoint an area within which these species survived the Pleistocene, the Southeast seems at least highly

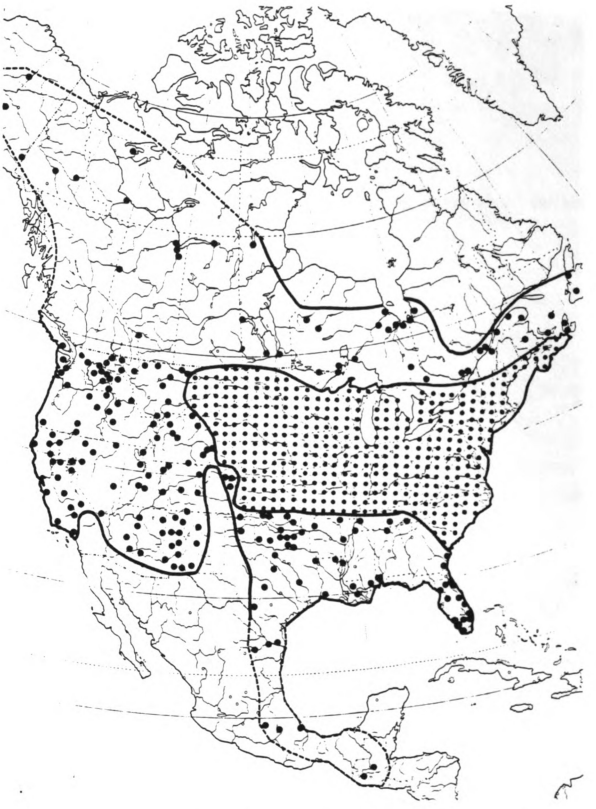
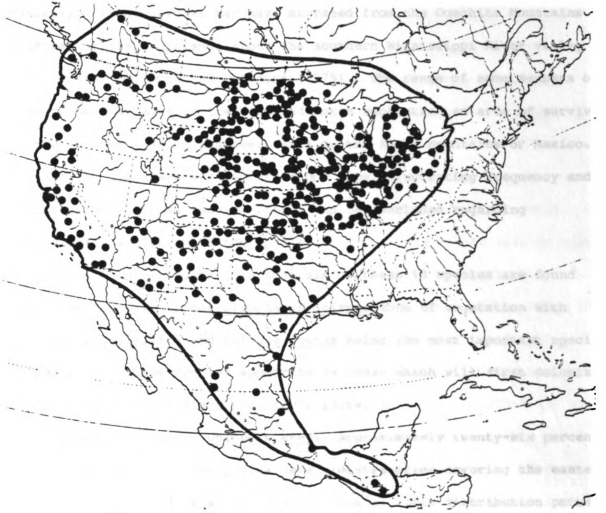
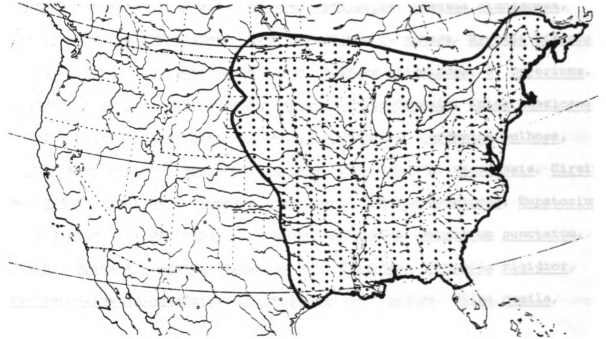


Figure 9. Distribution of Typha latifolia in North America and Central America.

Figure 10. Distribution of Equisetum laevigatum in North America and Central America.

Figure 11. Distribution of Amphicarpaea bracteata in North America.





unlikely. These species may have migrated from the Ouachita Mountains of Arkansas or the Blufflands along the southern Mississippi River valley as described by Delcourt and Delcourt (1975). The range of some members of this group lies more to the west and north suggesting an area of survival farther to the west or southwest such as the Rocky Mountains or Mexico. However, in the absence of accurate dot maps illustrating frequency and distribution of these species little can be concluded regarding post-glacial migration of the species.

It is interesting to note that six of these 18 species are found almost exclusively in the Eleocharis-Scirpus zone of vegetation with Eleocharis rostellata and Scirpus acutus being the most important species of the zone. These species appear to be those which will first colonize newly available area along the lake's shore.

Species of Eastern United States. Approximately twenty-six percent of the species in the study area have a distribution covering the eastern half of the United States and adjacent Canada. This distribution pattern is exemplified by Amphicarpaea bracteata (Figure 11). Other species included in this group are: Onoclea sensibilis, Osmunda cinnamomea, Thelypteris thelypteroides, Carex annectens, C. comosa, Hypoxis hirsuta, Juncus effusus, Polygonatum biflorum, Scirpus atrovirens, S. cyperinus, Spiranthes cernua, Acer rubrum, Amelanchier canadensis, Apios americana, Aster simplex var. simplex, Boehmeria cylindrica, Cardamine bulbosa, Cicuta maculata var. maculata, Circaea lutetiana ssp. canadensis, Cirsium muticum var. muticum, Clematis virginiana, Corylus americana, Eupatorium perfoliatum var. perfoliatum, Geranium maculatum, Hypericum punctatum, Liatris spicata, Monarda fistulosa var. fistulosa, Oxypolis rigidior, Parthenocisus quinquefolia, Phlox pilosa ssp. pilosa, Pilea pumila,

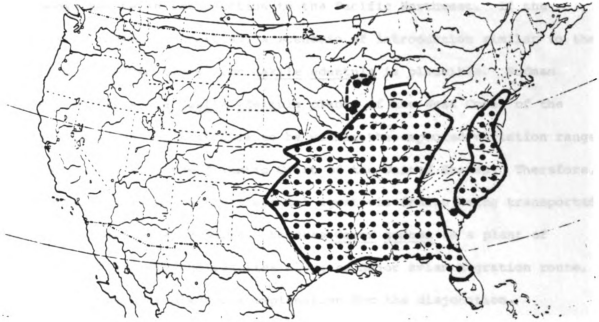
Podophyllum peltatum, Polygonum sagittatum, Prunus serotina, Quercus rubra, Q. velutina, Ranunculus recurvatus, Rosa palustris, Rubus occidentalis, Rudbeckia hirta var. pulcherrima, Sambucus canadensis, Senecio aureus, Solidago patula, S. rugosa ssp. rugosa var. rugosa, Ulmus americana, and Zizia aurea.

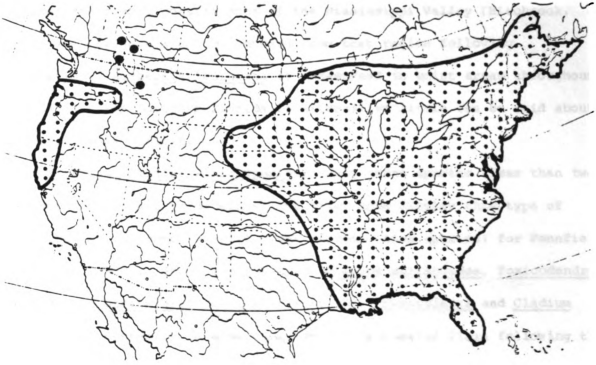
Two of the aforementioned species, Phlox pilosa ssp. pilosa (Figure 12) and Carex comosa (Figure 13), have interesting disjunct distributions. The separation of the P. pilosa range from east to west seems to correspond to higher elevation regions of the Appalachian Mountains, namely the Blue Ridge, Appalachian Plateau, and the Ridge and Valley Province (province names after Atwood, 1940). Since P. pilosa occurs in several physiographic provinces and several varied soil types (Levin, 1968), it is possible that altitude and physical relief act as barriers to dispersal of Phlox pilosa in the median areas. This hypothesis becomes uncertain, because along the coastal plain of South Carolina and Georgia where the relief is not great, the distribution of Phlox pilosa is somewhat discontinuous.

The disjunct distribution of Carex comosa involves much greater distances. Of nine references (see vascular plant list) none gives an indication of C. comosa existing in the western Great Plains, however, one specimen (Marshall 1161) at MSC was collected in far western Montana. If other such "interim" populations exist between the two main distribution areas, it is likely that C. comosa at one time had a much more widespread distribution. Elimination of the sedge from a large area of the Great Plains may have been in response to climatic changes resulting from mountain building in the Miocene. If the Montana specimen is an introduction and no native populations exist between the two main ranges,

Figure 12. Distribution of Phlox pilosa ssp. pilosa in North America.

Figure 13. Distribution of Carex comosa in North America.





C. comosa may be an introduction to the Pacific Northwest. If the species is indeed naturalized, a scenario of introduction similar to that outlined by Rodman (1974) for Cakile edentula is plausible. Rodman (1974) considers the Cakile edentula plants of the West Coast of the United States and of Australia to be within the expected variation range of plants native to the Atlantic Coast of the United States. Therefore, he credits man as being the dispersal agent via fruits being transported in the ballast tanks of ships. Because Carex comosa is a plant of wetlands and the disjunction lies along no major avian migration route, I see this as being a plausible explanation for the disjunction.

Lastly, I have placed Andropogon gerardii (Figure 14), Sorghastrum nutans, and Rudbeckia laciniata in this category even though their distributions cover 66 to 75 percent of the contiguous 48 states. Both grasses are common constituents of the Mississippi Valley (Hitchcock, 1950) and may have migrated outward from that region following glaciation. Rudbeckia laciniata is widespread in moist areas throughout the south (from northern Florida to Arizona) so little can be said about its migrational origin.

Northeast-Coastal Plain Species. Only three species (less than two percent) of the all those within the study area display this type of distribution, as compared with eight percent (nine species) for Pennfield Bog (Crow, 1968). These species are: Cladium mariscoides, Toxicodendron vernix, and Utricularia cornuta (Figure 15). Utricularia and Cladium seem almost certainly to have migrated up the Coastal Plain following the retreat of the glacial front. Toxicodendron vernix has a more extensive (though discontinuous) distribution inland from the Coastal Plain in the

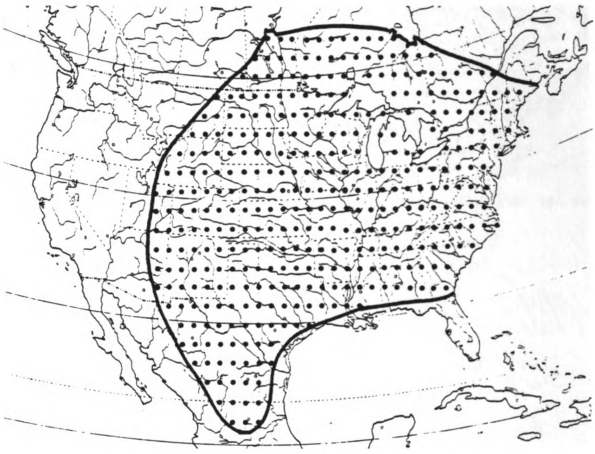
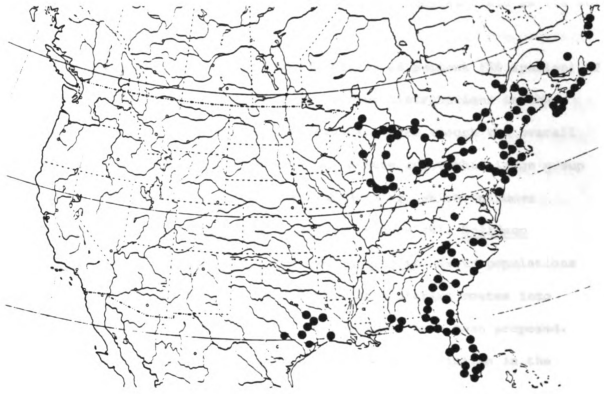
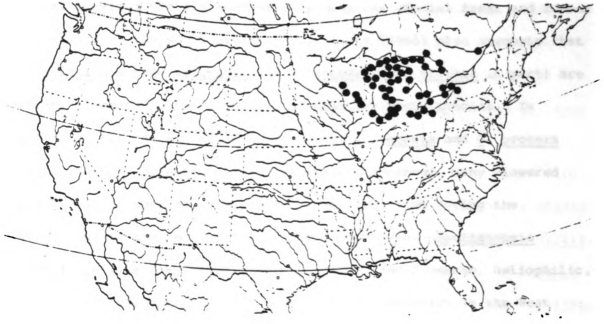


Figure 14. Distribution of *Andropogon gerardii* in North America.

Figure 15. Distribution of Utricularia cornuta in North America.

Figure 16. Distribution of Hypericum kalmianum in North America.





South, indicating that it may not have used the Coastal Plain as its sole route for northward migration.

Species of the Northeast. Approximately 28 percent (55 species) of the taxa in the Whitman Lake fen have current distributions in the northeast United States and adjacent Canada. Even though the overall distribution of each species is similar, I have split this large group into five sub-categories. The first subcategory, which includes Gentianopsis virgata, Hypericum kalmianum (Figure 16), Solidago ohioensis, and Valeriana sitchensis var. uliginosa, lacks populations south of the glacial margin. Speculation on migration routes into Michigan is difficult, but several possibilities have been proposed. McLaughlin (1931) suggests H. kalmianum survived glaciation in the Driftless Area of Wisconsin, whereas Iltis (1965) categorizes H. kalmianum as a "post-glacial neo-endemic" having evolved in the Great Lakes region in the last 10,000 years. Another possibility is that these species survived the Pleistocene very near the glacial front and former populations to the south are extinct. Iltis (1965) also suggests that V. sitchensis ssp. uliginosa and G. procera (=G. virgata in part) are western elements in the flora of northeastern North America. In support of his contention Iltis contrasts G. crinata and G. procera stating that G. crinata "evolved into a broad-leaved, many flowered late-blooming" species as a result of its isolation during the Pleistocene in the mesic, acidic Appalachian area. Gentianopsis procera "is a narrow-leaved, early-blooming, few-flowered, heliophilic, and calciophilic species" resulting from its isolation in the West where the growing season of the Great Plains is drier and shorter and the soil is more alkaline.

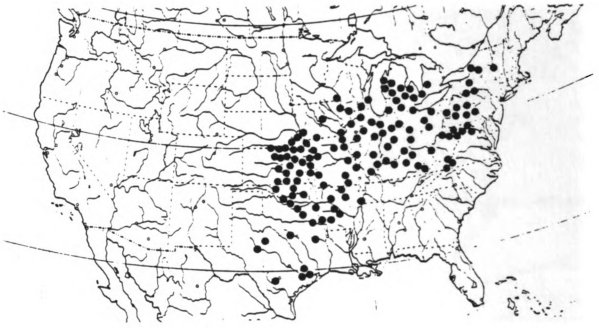
Of those species whose range does extend beyond the glacial boundary, a sizeable segment (over one third) appears to have migrated into Michigan from the Great Plains and Rocky Mountains. Species in this group include: Pteridium aquilinum var. latiusculum, Muhlenbergia mexicana, Spartina pectinata, Asclepias incarnata var. incarnata, Aster lucidulus, Cornus foemina ssp. racemosa, Gentiana andrewsii, Lathyrus palustris var. myrtifolius, Lobelia siphilitica, Lycopus americanus, Lysimachia quadriflora, Parnassia glauca (Iltis, 1965), Ribes missouriense, Rubus allegheniensis, Rumex orbiculatus, Solidago canadensis, Solidago riddellii, Spiraea alba (Kugel, 1958), Toxicodendron radicans ssp. negundo (Figure 17).

Another sub-category includes species which appear to have survived the Pleistocene in the Appalachian Mountains, as indicated by the extensions of their primary present ranges south of the glacial boundary through the Appalachians. This group includes: Pinus strobus, Dryopteris cristata, Muhlenbergia glomerata (Iltis, 1965), Symplocarpus foetidus, Aster umbellatus, Caltha palustris, Chelone glabra, Filipendula rubra, Galium asprellum, Helianthus giganteus, Mimulus ringens (Figure 18), Rhus typhina, Salix sericea, and Solidago uliginosa.

A fourth sub-category includes those species which migrated into Michigan from a survival point along the Coastal Plain near the glacial front. Species of this Coastal Plain element include: Carex sterilis, Liparis loeselii, Typha angustifolia (Figure 19), Agalinis paupercula (McLaughlin, 1932), Angelica atropurpurea, Epilobium strictum, Saxifraga pensylvanica, and Spiraea tomentosa.

Figure 17. Distribution of *Toxicodendron radicans* ssp. *negundo* in North America.

Figure 18. Distribution of *Mimulus ringens* in North America.



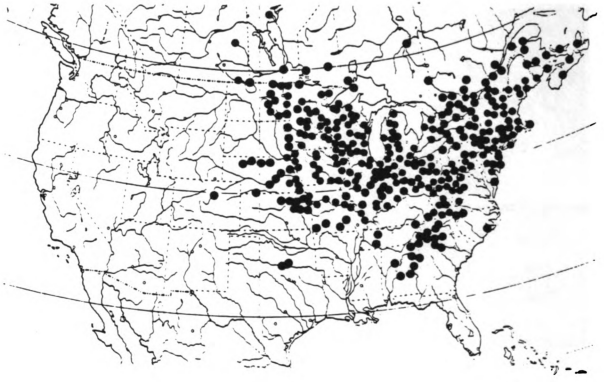
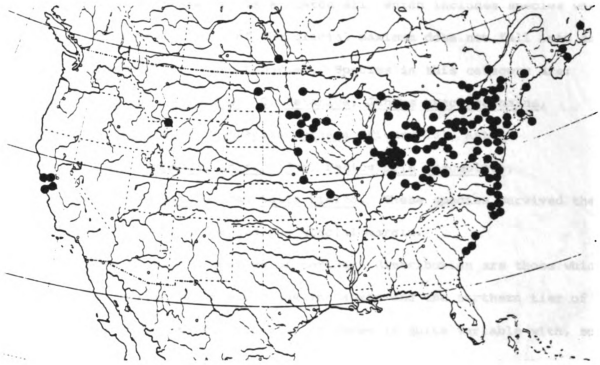
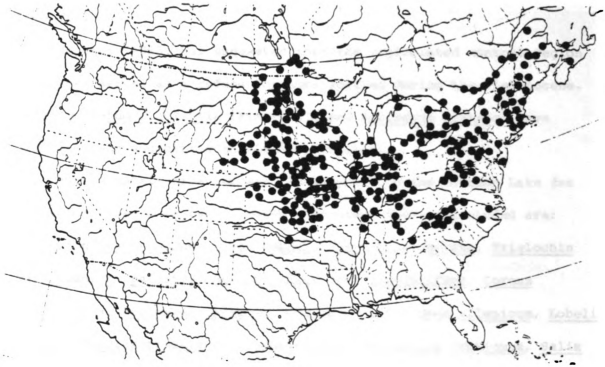


Figure 19. Distribution of Typha angustifolia in North America.

Figure 20. Distribution of Asclepias syriaca in North America.





The fifth sub-category is a "catch all" which includes species whose current distribution south of the glacial maximum does not fall into any of the aforementioned sub-categories. Species in this category are: Carex stricta var. strictior, C. tetanica, Juncus brachycephalus, Rhyncospora capillacea, Asclepias syriaca (Figure 20), Aster novae-angliae, Campanula aparinoides, Pedicularis lanceolata, Pycnanthemum virginianum, and Salix rigida. These species survived the Pleistocene "somewhere" beyond the glacial margin.

Northern Species. Species of northern distribution are those which have a major portion of their range in Canada and the northern tier of states. The northward distribution of these is quite variable with, some reaching the Arctic Slope and others possessing a northern limit substantially farther south. Species with such a distribution comprise approximately 25 percent (49 species) of the total flora of the Whitman Lake fen.

Heusser (1965) has suggested that the unglaciated central region of Alaska served as a refuge for some species during the Pleistocene. Only Equisetum fluviatile (Figure 21) and Equisetum pratense have distributions suggesting an Alaskan refugium.

Approximately nine percent (18 species) of the Whitman Lake fen flora comprises a western element. Northern species included are: Agropyron trachycaulum, Carex bebbii, Hierochloe odorata, Triglochin maritimum, T. palustre, Betula pumila var. glandulifera, Cornus stolonifera, Epilobium ciliatum, Galium boreale, Geum allepicum, Lobelia kalmii, Populus tremula ssp. tremuloides, Potentilla fruticosa, Salix bebbiana, Scutellaria galericulata, Stellaria longifolia, Urtica dioica ssp. gracilis, and Viola nephrophylla (Figure 22).

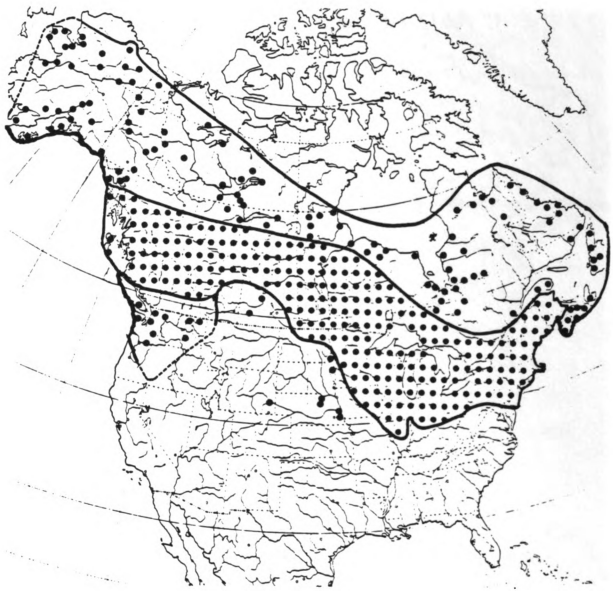
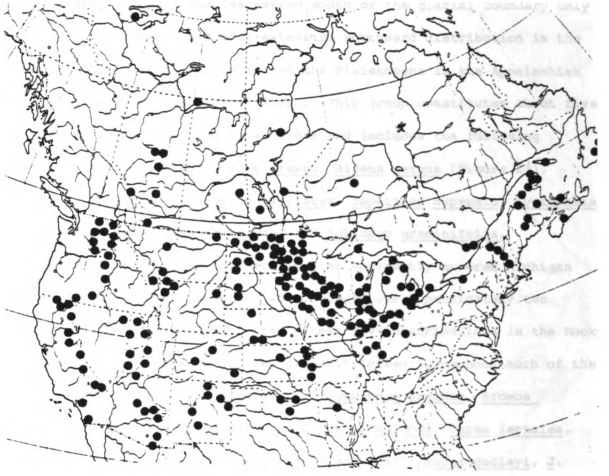
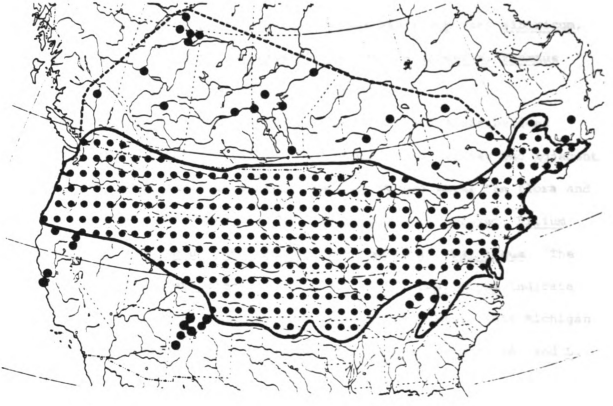


Figure 21. Distribution of Equisetum fluviatile in North America.

Figure 22. Distribution of Viola nephrophylla in North America.

Figure 23. Distribution of Bidens cernua in North America.





Several northern species extend south of the glacial boundary only in the east or have their most extensive southward distribution in the east, suggesting that they survived the Pleistocene in the Appalachian Mountains or along the Coastal Plain. This group constitutes about five percent (9 species) of the total flora and includes the following species: Larix laricina, Carex crawei, Bidens cernua (Figure 23), Comandra umbellata, Eupatorium maculatum, Impatiens capensis, Lysimachia thrysiflora, Ranunculus abortivus, and Solidago graminifolia.

A final group of 20 northern species apparently entered Michigan from the south. These species, which constitute approximately ten percent of the Whitman Lake flora, either have distributions in the Rocky and Appalachian Mountains or they are distributed throughout much of the United States. Species included are: Equisetum arvense, Bromus ciliatus, Calamagrostis canadensis, Carex lanuginosa, Carex leptalea, Carex stipata, Deschampsis cespitosa (Figure 24), Juncus dudleyi, J. nodosus, Phalaris arundinacea, Scirpus validus, Smilacina stellata, Achillea millefolium ssp. lanulosa, Apocynum sibiricum var. sibiricum, Cicuta bulbifera, Erigeron philadelphicus, Mentha arvensis, Rhamnus alnifolia, Rubus strigosus, and Salix discolor.

Central Species. These species possess current distributions covering a part of the central portion of the United States and adjacent Canada. The group makes up only two percent of the total fen flora and includes the following species: Iris virginica var. shrevei, Lilium michiganense, Sporobolus heterolepis, and Thalictrum dasycarpum. The distribution of S. heterolepis (Figure 25) and T. dasycarpum indicate that they have migrated from the west (perhaps southwest) into Michigan since the Pleistocene. Iris virginica var. shrevei (Figure 26) and L.

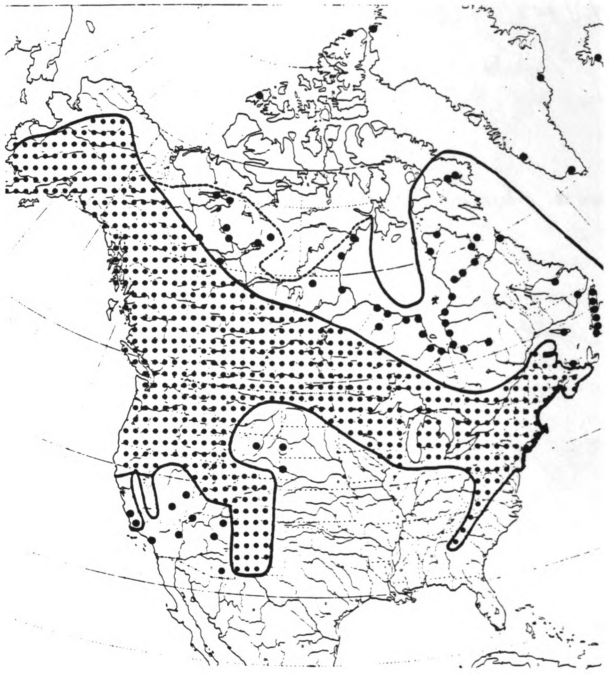
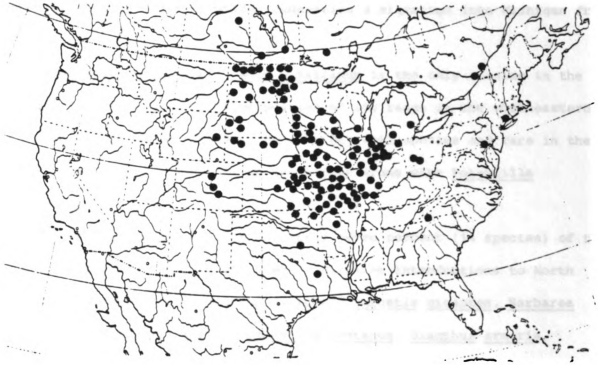
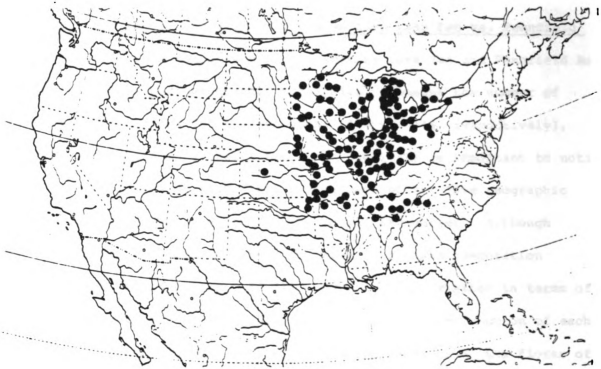


Figure 24. Distribution of Deschampsia cespitosa in North America.

Figure 25. Distribution of Sporobolus heterolepis in North America.

Figure 26. Distribution of Iris virginica var. shrevei in North America.





michiganense have distributions suggesting a migration into Michigan from the south.

Southeastern Species. Rhus copallinum is the only species in the study area which has the major portion of its range in the southeastern quarter of the United States. It is a dry soil species and rare in the study area, being found only in the higher areas with Potentilla fruticosa.

Introduced Species. Approximately seven percent (14 species) of the Whitman Lake fen flora is composed of Eurasian introductions to North America. Species in this group include: Agrostis gigantea, Barbarea vulgaris, Calystegia sepium, Cerastium fontanum, Dianthus armeria, Hieracium caespitosum, Hypericum perforatum, Leucanthemum vulgare, Lythrum salicaria, Nasturtium officinale, Prunella vulgaris, Rumex obtusifolius, Solanum dulcamara, and Taraxacum officinale.

Phytogeographic Comparison of the Whitman Lake Fen vs. Pennfield Bog. Table 14 is a comparison of the Whitman Lake fen and Pennfield Bog floras and their phytogeographic affinities. Because the number of species found differs for the two areas (194 vs. 144, respectively), percent values are more useful for comparison. It is important to notice that the proportion of each flora having each of the five geographic divisions Crow (1968) used is similar in all categories. Although the two floras are very different in terms of species composition (Coefficient of Similarity = 27.71%), they are very similar in terms of their geographic affinities based upon the current distribution of each species. Implicit in this is that similar proportions of the floras of each area migrated into Michigan from the same origin. However, closer examination and lumping of subcategories provides a somewhat different

Table 14. Comparison of Geographic Affinities Between Whitman Lake Fen and Pennfield Bog[f] (Blank spaces indicate unreported data.)

Geographic Affinity	Number of Species		Percent of Total Flora	
	Whitman Lake Fen	Pennfield Bog	Whitman Lake Fen	Pennfield Bog
Widespread	18	13	9.3	10[a]
Eastern Half of U.S.	50	36	25.8	26[b]
Northeast & Coastal Plain	3	11	1.5	8
Northeast	55	40	28.4	28
:Completely North of Glacial Margin	4		2.1	13.9
:Appalachian Element	14	20	7.2	11.8
:Coastal Plain Element	8	17	4.1	2.1
:West & Southwest Element	19	3	9.8	
:Generally Northeast (South)	10		5.2	
Northern Species	49	28[c]	24.7	28
:Alaskan Element	2	3	1.0	2.1
:Western Element	18	13	9.3	14[d]
:Appalachians & Coastal Plain	9	12	4.7	9[e]
:Generally South	20		10.3	
Central Species	4		2.1	
:Western Element	2		1.0	
:Southern Element	2		1.0	
Southeastern Species	1		0.5	
Introduced Species	14		7.2	

[a] 9.0% by my calculations.
[b] 25.0% by my calculations.
[c] Crow did not report those species for which no geographic affinity could be determined, therefore, this figure does not equal 28% of the total.
[d] 9.0% by my calculations.
[e] 8.0% by my calculations.
[f] Bog data from Crow (1968).

picture regarding routes of migration. As is true for Pennfield Bog, the flora of the Whitman Lake fen was produced through four major migratory routes: 52.1% of the species are southern, 20.1% are of western affinity, 17.5% are eastern, and 1% are of Alaskan affinity. For Pennfield Bog, Crow (1968) found that 36% of the species are southern, 42% are eastern, 10% are of western affinity, and 2% are of Alaskan affinity (Figure 27). The difference in the percentage of the flora with western affinity between the two areas may be a result of the difference between the eastern U.S. and the western U.S. environment. Since the Whitman Lake fen is considerably more alkaline than Pennfield Bog, it is reasonable that more western species are found there, as the western species survived the Pleistocene in a more alkaline region of North America and are incapable of existing under acid bog conditions. This same logic can be applied to explain the predominance of "eastern" species in the bog vs. the fen (Iltis, 1965). Differences between the percentages of "southern" plants may be a result of subjective decisions in placing taxa into particular groups. More subjectivity is required to categorize species whose distribution records are not concise dot maps. An equal percentage of species was either introduced or of indecipherable distribution to be included in the analysis.

Vascular Plants of the Whitman Lake Wetland

A total of 212 species of vascular plants has been identified from the Whitman Lake wetland, with a complete set of voucher specimens deposited in the Beal-Darlington Herbarium of Michigan State University (MSC). Unless otherwise indicated, the collection numbers are my own and those species observed, but not collected, also being indicated.

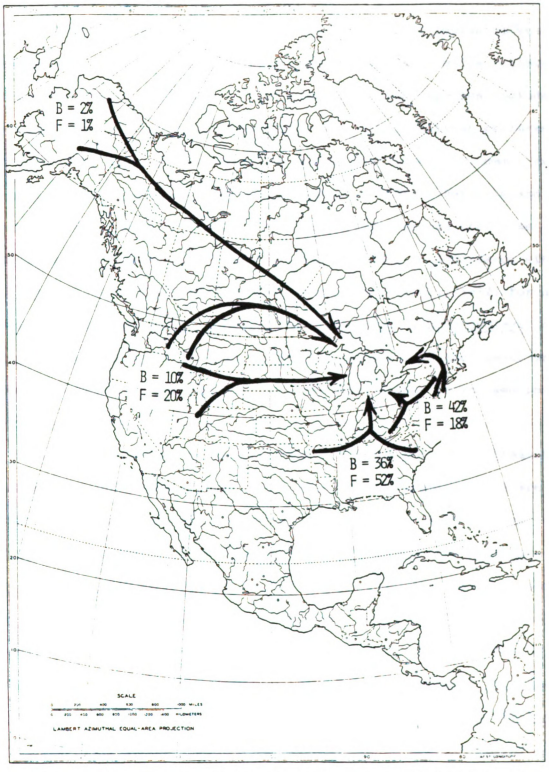


Figure 27. A comparison of proposed post-Pleistocene migration routes into Michigan of the taxa represented in the Whitman Lake fen and Pennfield Bog floras. Percent values have been rounded to the nearest whole number and represent the portion of each flora which migrated from each particular region of North America. The "B" and "F" values represent the Pennfield Bog and Whitman Lake fen floras, respectively. (Map modified after Crow [1968].)

Organization of the families within the Magnoliopsida and Liliopsida follows Cronquist (1981), whereas the organization for Equisetophyta, Pteridophyta, Coniferophyta, and the Magnoliophyta as a whole follows Gleason and Cronquist (1963). The discussion of each species includes frequency and location within the study area, habit, habitat preference, and North American (in some instances world) distribution. Common names given are those listed by Gleason and Cronquist (1963), Peterson and McKenny (1968), Fernald (1970), and/or Voss (1972) unless otherwise stipulated. In addition, scientific names used are in accordance with the National List of Scientific Plant Names (Rice et al., 1982) for all species except Eupatorium maculatum var. maculatum, Juncus dudleyi, and Solidago graminifolia. In those instances where I feel the reader may be unfamiliar with the accepted binomial, the more widely known name is given in brackets.

Of the 212 species of vascular plants found within the Whitman Lake wetland 194 species are represented within the fen community and are listed in the phytogeographic section of this paper. Four species (Fragaria virginica, Potentilla simplex, Salix exigua ssp. interior, and Sassafras albidum) were collected only in the sandy soil of an abandoned road bed in the north end of the study area. I do not consider this to be part of the fen, therefore, these species are omitted from the phytogeographic analysis. Botrychium virginianum, Juniperus virginiana, Arisaema triphyllum, Dioscorea villosa, Platanthera psychodes, Smilax lasioneura, Cuscuta cephalanthi, Lindera benzoin, Osmorhiza claytonii, Rosa multiflora, Salix petiolaris, and Viburnum cassinoides are species found only in the shrub-carr community and are also omitted from the phytogeographic analysis. Finally, Carya glabra is represented by a

single wind fall victim which is actually rooted on the forested slope and Cornus florida is represented by rare individuals (rooted on the forested slope) whose lowermost branches intermingle with the vegetation of the Carex-Amphicarpaea zone; both species are omitted from the phytogeographic analysis.

Equisetophyta

Equisetaceae

Equisetum arvense L.

Common horsetail. Rare in sparse herbaceous cover of the northeast corner of the wetland. 503.

Herbaceous perennial with annual dimorphic stems from deep seated tuber-bearing rhizomes. Damp open woods and thickets, embankments, and other moist to moderately dry habitats. A cosmopolitan species. In North America from South Carolina, Arkansas, northern Texas, and northern Baja California, north to northern Alaska, Ellesmere Island, and northern Greenland (Raup, 1947a; Gleason and Cronquist, 1963; Porsild, 1964; Fernald, 1970; Young, 1971; Mickel, 1979).

Equisetum fluviatile L.

Water horsetail. Rare. Most commonly found in open, water saturated soils. 218, 307, 331, 507.

Herbaceous perennial with annual stems in shallow water, wet shores, and meadows. A circumboreal species. In North America from Newfoundland, Labrador, and Nova Scotia to Alaska, south to Oregon, Nebraska, Indiana, and Virginia (Schaffner, 1921; Deam, 1940; Raup, 1947a, b; Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970;

Hitchcock and Cronquist, 1973; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978a; Wherry, Fogg, and Wahl, 1979).

Equisetum laevigatum A. Br.

Horsetail. Rare. Found in open herbaceous areas of vegetation. 262, 323.

Rhizomatous, herbaceous perennial of meadows, prairies, sandy shores, and roadsides. Quebec to British Columbia, south to Guatemala, Texas, northwestern Louisiana, northern Mississippi and Georgia, and North Carolina (Rydberg, 1906; Schaffner, 1921, 1939; Deam, 1940; Davis, 1952; Steyermark, 1963; Kearney and Peebles, 1969; Mohlenbrock and Ladd, 1978; Mickel, 1979; Martin and Hutchins, 1980).

Equisetum pratense Ehrh.

Meadow horsetail. Rare. Scattered within open herbaceous vegetation. 322.

Rhizomatous, herbaceous perennial with annual stems in moist woods, thickets, calcareous meadows, and various other moist habitats. A circumboreal species. In North America, throughout Canada and Alaska, south to Montana, South Dakota, Iowa, Michigan, and New Jersey. Also reported in Colorado (Schaffner, 1921; Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977).

Pteridophyta

Osmundaceae

Osmunda cinnamonea L.

Cinnamon fern. Rare. Growing beneath shrub-carr in south end of study area. Stoynoff (pers. observ.).

Stoutly rhizomatous perennial herb. Fronds clustered and young stipe densely wooly. Swamps, stream banks, and other wet areas. A circumboreal species. In North America from Labrador to Minnesota, south to New Mexico, Mexico, Texas, and Florida (Gleason and Cronquist, 1963; Hulten, 1964; Mickel, 1979).

Ophioglossaceae

Botrychium virginianum (L.) Sw.

Rattlesnake fern. Rare, beneath Cornus shrub-carr at edge of forest in northeast corner of the study area. 501.

Soft, fleshy, herbaceous perennial from deep rhizomes in neutral or near-neutral soils of deciduous or mixed forest. A circumboreal species; in North America from Newfoundland, southern Labrador, and southern Quebec to central Manitoba, southwestern Mackenzie District, and the eastern Aleutian Islands, south to Oregon, Idaho, Arizona, northcentral Colorado, eastern Texas, and Florida. Also in scattered populations in Mexico (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Scoggan, 1978a; Mickel, 1979).

Polypodiaceae

Dryopteris cristata (L.) Gray

Crested woodfern. Occasional in open areas dominated by Carex stricta. 321.

Herbaceous perennial from stout creeping rhizome in marshes, wet woods, and generally boggy, swamps, open ground. An amphi-Atlantic species. In North America, Newfoundland and Nova Scotia to extreme southeastern British Columbia, south to Idaho, Kansas, northern Louisiana, Tennessee, and North Carolina (Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977).

Onoclea sensibilis L.

Sensitive fern. Abundant, occasionally forming dense stands in open herbaceous vegetation. 439.

Herbaceous, rhizomatous perennial of swamps, meadows, thickets, low woods and other such areas in neutral to slightly acid soils. Species of North America and eastern Asia. In North America from Newfoundland and Labrador to Manitoba, south to Colorado, Texas, Louisiana, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977).

Thelypteris thelypteroides (Michx.) J. Holub. [Thelypteris palustris (Calisb.) Schott var. pubescens (Lawson) Fern.

Marsh fern. Abundant in all areas of open herbaceous vegetation. 438.

Rhizomatous, herbaceous perennial in marshes, swamps, bogs, and low thickets or woods. A circumpolar species of eastern North America, Eurasia, South Africa, southern India, and New Zealand. This variety in North America from Newfoundland to southeastern Manitoba, south to Oklahoma, Tennessee, Alabama, and Florida (Gleason and Cronquist, 1963; Hulten, 1964; Radford et al., 1968; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977; Mickel, 1979).

Pteridium aquilinum (L.) Kuhn var. latiusculum (Desv.) Heller

Bracken fern. Rare. Growing only on higher ground along northwest lake shore with Corylus americana. 517.

Coarse, herbaceous perennial with a creeping rhizome. Open, dry woods, clearings, and burns. A highly variable circumboreal species and from tropical and temperate regions. This variety in North America from Newfoundland to Minnesota, south to Oklahoma, Arkansas, and mountains of Tennessee and North Carolina. Reported isolated populations in western South Dakota, Wyoming, Colorado, New Mexico, and northeastern Mexico (Tryon, 1941; Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977; Mickel, 1979).

Coniferophyta

Pinaceae

Pinus strobus L.

White pine. Rare. Only one seedling found growing along side spring flow. 380, 518.

Tree to seventy meters with furrowed thick bark and fascicles bearing five leaves. Many habitats, but especially well drained fertile

soil. Newfoundland and Nova Scotia to extreme southeastern Manitoba, south to Iowa, northern Illinois, Tennessee, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Larix laricina (DuRoi) K. Koch

Tamarack. Local. One large tree (approximately 20 meters tall) and several saplings along edge of sedge meadow in far southwest corner of area. 339.

Tree to twenty meters with deciduous leaves in clusters on short spurs. In swamps and bogs. Newfoundland, Labrador, and Nova Scotia and Alaska, south to Minnesota, extreme northeastern Illinois, northern Indiana and Ohio, and northern West Virginia (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Cupressaceae

Juniperus virginiana L.

Red-cedar. Rare, one specimen in shrub-carr of the south end of the study area. 513.

Shrub or tree to 25 meters. In a variety of soil types, but most often dry and commonly calcareous. From southern Quebec and Maine to North Dakota, south to Alabama and Texas (Gleason and Cronquist, 1963; Fernald, 1970).

Magnoliophyta

Liliopsida

Alismataceae

Sagittaria latifolia Willd.

Arrow-head. Occasional along lake's shore. 520.

Erect, sagittate-leaved, herbaceous, aquatic from rhizomes. Streams, ponds, and swamps; Nova Scotia and Quebec to southern British Columbia, south to northern South America (Gleason and Cronquist, 1963).

Juncaginaceae

Triglochin maritimum L.

Arrow grass. Rare. In small mudflats along spring flows, near lake. 315.

Erect, herbaceous perennial of brackish or freshwater marshes or bogs. A circumboreal species also possibly found in Patagonia. In North America from Labrador to Alaska, south to Baja Mexico, northern Mexico, Oklahoma, Indiana, Ohio, and Delaware (Muenscher, 1944; Camp, 1947; Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970; Hitchcock and Cronquist, 1973).

Triglochin palustre L.

Arrow grass. Rare. In small mudflats where spring flows approach the lake. 316, 399.

Bulb bearing, rhizomatous, herbaceous perennial of wet calcareous or brackish habitats. Labrador to Alaska, south to California, New Mexico, Nebraska, Illinois, Pennsylvania, and Massachusetts. A circumboreal species, also in southern South America and New Zealand (Muenscher, 1944;

Camp, 1947; Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970; Hitchcock and Cronquist, 1973).

Araceae

Arisaema triphyllum (L.) Schott var. triphyllum

Jack-in-the-pulpit. Rare, beneath shrub-carr along east lake shore. 484.

Herbaceous perennial from a very acrid corm. Swamps, peaty bogs, and wet woods. Nova Scotia to Minnesota, south to Louisiana and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Symplocarpus foetidus (L.) Nutt.

Skunk cabbage. Abundant in very wet shaded areas along forest's edge. 487.

Herbaceous perennial from a stout, erect rhizome. Wet meadows, swampy woods, and thickets. A species of eastern Asia and North America. In North America from Nova Scotia to western Manitoba, south to Iowa, Tennessee, and northern Georgia (Fernald, 1918, 1970; Gleason and Cronquist, 1963; Voss, 1964b).

Lemnaceae

Lemna minor L.

Duckweed. Local. Densely covering quieter pools, within spring flows. 511.

Free floating herb with an obscurely trinerved thallus. In quiet waters of almost every tropical and temperate region of the world

(Gleason and Cronquist, 1963; Hulten, 1964; Daubs, 1965; Porsild, 1966; Fernald, 1970; Voss, 1972).

Juncaceae

Juncus brachycephalus (Engelm.) Buch.

Short-headed rush. Occasional in more sparsely populated herbaceous vegetation encircling the lake. 337, 361, 473, 478.

Herbaceous, densely cespitose perennial of calcarcous shores, wet meadows, marshes, etc. Cape Breton Island to northern Ontario, south to Minnesota, Illinois, Ohio, and New Jersey (Gleason and Cronquist, 1963; Fernald, 1970).

Juncus dudleyi Wieg.

Dudley's rush. Occasional in more sparsely populated herbaceous vegetation of the area. 254.

Herbaceous perennial in pale colored tussocks in damp to dry calcareous (neutral) soils. Newfoundland to southwestern Mackenzie District and southern Yukon, south to Washington, California, Arizona, Texas, Tennessee, and Virginia (Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Scoggan, 1978a).

Juncus dudleyi is listed as Juncus tenuis var. dudleyi (Weig.) F.J. Herm. in Rice et al. (1982). Voss (1972) indicates that if this species is to be transferred to the varietal level the correct name would be Juncus tenuis var. uniflorus (Farw.) Farw.

Juncus effusus L.

Soft rush. Occasional in more sparsely populated herbaceous vegetation of the area. 216, 406.

Herbaceous perennial in dense tussocks from stout rhizomes. Open marshes, meadows, and peaty swamps, and thickets. A nearly cosmopolitan species with highly variable morphology. Six varieties with overlapping ranges are found in eastern North America from Newfoundland to Minnesota, south to Florida and east Texas. Michigan plants are too variable for recognition of varieties. (Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Voss, 1972; Hitchcock and Cronquist, 1973).

Juncus nodosus L.

Knotty rush. Occasional in more sparsely populated herbaceous vegetation of area. 284, 362, 372, 400, 462.

Erect, herbaceous perennial from a slender, tuber-bearing rhizome. Swamps, marshes, bogs, and wet shores. Newfoundland to northern MacKenzie District and central Alaska, south to California, New Mexico, Texas, Missouri, Indiana, and Virginia (Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Welsh, 1974; Scoggan, 1978a).

Cyperaceae

Carex annectens Bickn.

Bristly-spiked sedge (Britton, 1901). Rare. In open areas. 220, 229.

Cespitose, herbaceous perennial from stout fibrillose roots. Low open roadsides and marshes. Predominately a coastal plain species.

Maine to Wisconsin, south to Texas and Florida (Mackenzie, 1931; Hermann, 1941).

Carex bebbii (Bailey) Fern.

Blunt broom sedge (Britton, 1901). Rare. Scattered in open herbaceous areas. 243, 278, 306, 334, 373.

Densely cespitose, herbaceous perennial from short fibrillose roots. Open bogs, marshes, and swampy thickets, especially in calcareous soils. Newfoundland to southern Alaska and southern Mackenzie District, south to Washington, Colorado, Iowa, Indiana, and New Jersey (Mackenzie, 1931; Hermann, 1941; Gleason and Cronquist, 1963; Scoggan, 1978a).

Carex comosa Boott

Bristly sedge (Britton, 1901). In clumps along lake's edge. 295.

Herbaceous, densely cespitose perennial from short, stout rootstocks. Open stream banks, swamps, and non-acid soils. Maine to western Ontario, south to Minnesota, Nebraska, Louisiana, and Florida. Disjunct populations locally from Washington to San Francisco Bay and inland to northern Idaho (Mackenzie, 1931; Hermann, 1941; Hulten, 1958; Marie-Victorin, 1964; Boivin, 1967; Hitchcock et al., 1971; Hitchcock and Cronquist, 1973; Barkley, 1977; Scoggan, 1978a).

Carex crawei Dewey

Crawe's sedge (Britton, 1901). Rare in very sparse herbaceous vegetation along spring flow in northwest corner of the wetland. 495.

Solitary to loosely cespitose herbaceous perennial from long rhizomes. Calcareous shores, wet meadows, and glades; Newfoundland to

southeastern British Columbia, south to Washington, Utah, Kansas, northern Georgia, and New Jersey (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978a). The species is rare in the intermountain region of the western U.S. (Cronquist et al., 1977).

Carex hystericina Willd.

Porcupine sedge (Britton, 1901). Frequent, along lake's edge. 221, 263, 280, 312.

Stoloniferous, cespitose, herbaceous perennial of swamps, wet meadows, and calcareous soils. New Brunswick to southern British Columbia, south to Washington and northern California, Arizona, Texas, Missouri, Kentucky, and Virginia. A local species in the Southwest (Mackenzie, 1931; Hermann, 1941; Hitchcock and Cronquist, 1973).

Carex lanuginosa Michx.

Woolly sedge (Britton, 1901). In open herbaceous vegetation. 258.

Herbaceous, cespitose perennial from scaly, tough stolons. Marshes, wet meadows, swamps, and predominantly in calcareous soils. Newfoundland, New Brunswick, and Nova Scotia to British Columbia, south to southern California, Texas, Arkansas, Tennessee, and Delaware (Mackenzie, 1931; Hermann, 1941; Hulten, 1964; Hitchcock and Cronquist, 1973).

Carex leptalea Wahl.

Bristle-stalked sedge (Britton, 1901). Local. Most commonly found growing along spring flows. 240, 302.

A densely cespitose, herbaceous perennial from scaly rootstocks. Common in sphagnum and black spruce bogs, less common in wet peaty meadows and marshes. Newfoundland, Labrador, and Nova Scotia to Alaska, south to California, Colorado, Louisiana, and Florida (Mackenzie, 1931; Hermann, 1941; Raup, 1947a; Hitchcock and Cronquist, 1973).

Carex sterilis Willd.

Little prickly sedge (Britton, 1901). Occasional. In open herbaceous vegetation. 264.

Herbaceous, very densely cespitose perennial from fibrillose rootstocks. Swampy meadows, bogs, and marshes in calcareous soils. Newfoundland to Minnesota, south to Illinois and New Jersey (Mackenzie, 1931; Hermann, 1941).

Carex stipata Muhl.

Awl-fruited sedge (Britton, 1901). Rare along creek in south end of study area. 301.

Stout, densely cespitose, herbaceous perennial. Swampy woods, wet meadows, and other low grounds. Newfoundland and southern Labrador to southern Alaska, south to California, Texas, and Florida (Hermann, 1941; Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978a).

Carex stricta Lam. var. strictior (Dewey) Carey

Tussock sedge (Britton, 1901). Abundant, occupying major portions of the open herbaceous zones. 226, 266, 277, 356.

Herbaceous perennial, often in large, dense tussocks from inconspicuous scaly stolons. Boggy lake shores, open swamps, marshes,

and roadsides. Maine and Quebec to Minnesota, south to Iowa, Texas, eastern Tennessee, and western North Carolina (Mackenzie, 1931; Hermann, 1941; Gleason and Cronquist, 1963; Fernald, 1970).

Carex tetanica Schk.

Wood's sedge (Britton, 1901). Rare, scattered within areas dominated by Carex stricta along lake's shore. 249, 283.

Cespitose, herbaceous, perennial from slender rhizomes. Calcareous bogs, meadows, and woods. Massachusetts to southeastern Saskatchewan, south to Missouri and Virginia (Hermann, 1941; Scoggan, 1957; Gleason and Cronquist, 1963; Fernald, 1970).

Cladium mariscoides (Muhl.) Torr.

Twig-rush. Occasional within fen vegetation along lake's edge. 261, 289, 319, 346, 463.

Herbaceous perennial with obscure stolons. Marshes, swamps, and usually calcareous or saline places. Southwestern Newfoundland to Minnesota, south to northern Illinois, Ohio, Pennsylvania, south along Coastal Plain to Texas (Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Raymond, 1971). An outlier population in south central Saskatchewan, also (Scoggan, 1978a).

Cyperus rivularis Kunth

Stream nut-grass. Rare, within sparsely populated mud flat of spring flow at lake's edge. 476.

A fibrous rooted annual to two decimeters. Wet sandy, muddy, or peaty places and other wet soils. Maine and Quebec to North Dakota,

south to California, Mexico, Texas, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970).

Cyperus strigosus L.

Lean nut-grass. Rare, within mudflat of creek in south end of study area. 393.

Herbaceous perennial from hard corm-like rhizome. Moist fields, meadows, damp thickets, etc. A widespread species from Maine and Quebec to the Pacific Coast, south to New Mexico, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock et al., 1971).

Eleocharis rostellata Torrey

Spike-rush. Abundant along lake shore and in far southwest corner of area. 225, 253.

Cespitose, herbaceous perennial from creeping rhizomes. Shores, marshes, bogs, and often in calcareous soils. Nova Scotia south along coastal plain to Florida and the West Indies, locally west to Wisconsin and Illinois; also, British Columbia to Oklahoma and Mexico. Additionally reported from Andes in South America (Svenson, 1934, 1957; Gleason and Cronquist, 1963; Fernald, 1970; Voss, 1972).

Rhynchospora capillacea Torrey

Beak-rush. Local in zone along lake's shore at edges of spring flows and scattered in sparse vegetation in wetter soils to the south. 314, 371, 461.

Cespitose, fibrous-rooted, perennial herb of bogs, shores, and calcareous swamps. Newfoundland to Saskatchewan, south to South Dakota,

Missouri, Tennessee, and Virginia (Gale, 1944; Gleason and Cronquist, 1963; Fernald, 1970).

Scirpus acutus Muhl.

Hardstem bulrush. Common along lake shore and in shallow water, predominantly with Eleocharis rostellata. 230.

Herbaceous perennial from stout rhizomes and spongy roots. Shallow water, shores, and swamps. Newfoundland to Alaska, south to California, Texas, Tennessee, and North Carolina (Thornton, 1934; Beetle, 1947; Gleason and Cronquist, 1963; Hulten, 1964).

Scirpus americanus Pers.

Threesquare. Local. Predominantly along northwest shore of the lake. 241.

Herbaceous perennial from scaleless stolons, along lake and stream margins. A widespread species from Labrador to Alaska and south through all of the contiguous 48 states. Beetle (1947) considers ours to be an intermediate between var. longispicatus and var. americanus, whereas Koyama (1963) gives them the rank of subspecies rather than variety. At any rate the species is amphi-Atlantic extending from North America to Eurasia (introduction?), south through South America, and west to New Zealand and southern Australia (Ramaley, 1939; Beetle, 1947; Hulten, 1958; Koyama, 1963).

Scirpus atrovirens Willd.

Dark-green bulrush (Britton, 1901). Rare, along lake's shore. 217, 296.

Herbaceous perennial from fibrous roots in moist meadows, marshes, bogs, and along streams. Newfoundland to Saskatchewan, south to eastern Texas and Georgia. Also reported from one area in Arizona's White Mountains (Beetle, 1947; Schuyler, 1967), but this is not supported by Kearney and Peebles (1969).

Scirpus cyperinus (L.) Kunth var. cyperinus

Wool-grass. Rare. Small clump in area dominated by Phalaris at south end of lake. 440.

Herbaceous perennial in dense tussocks from fibrously branching rhizomes. Moist meadows, marshes, and often in disturbed areas. Newfoundland to Manitoba, south to eastern Texas and Florida. Disjuncts also reported from Washington, Oregon, and Hidalgo, Mexico (Schuyler, 1967; Hitchcock and Cronquist, 1973).

Scirpus validus Vahl

Great bulrush. Rare, one small patch with Typha in spring flow of southwest corner of area. 340.

Herbaceous perennial from slender scaly rhizomes. Swamps, marshes, and brackish or fresh shallow waters. Newfoundland and Florida, west to central Alaska and the Pacific Coast (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978a).

Poaceae

Agropyron trachycaulum (Link) Malte var. novae-angliae (Scribner) Fern.

Slender wheatgrass. Occasional in higher drier areas of the fen. 273, 325.

Herbaceous perennial of rocky or peaty soils. Nova Scotia, Newfoundland, and northern Labrador to Ellesmere Island and northern Alaska, south to Mexico, Kansas, Missouri, West Virginia, and New Jersey (Raup, 1947a; Hitchcock, 1950; Fernald, 1970; Welsh, 1974; Scoggan, 1978a).

Agrostis gigantea Roth

Redtop. Rare. In area along path to dock. 351, 383.

Herbaceous perennial from creeping rhizomes. In wet and dry areas. Introduced to North America from Eurasia and now cultivated and escaped into many parts (Hitchcock, 1950; Fernald, 1970; Voss, 1972).

Andropogon gerardii Vitman

Big bluestem. Frequent in higher, drier areas. 410.

Herbaceous perennial with culms to two meters and sometimes short rhizomes. Open woods, prairie, and other dry soil areas. Maine and Quebec to central Manitoba and southeastern Saskatchewan, south to eastern Utah and Arizona, northern Mexico, and the panhandle of Florida (Rydberg, 1906; Deam, 1940; Hitchcock, 1950; Pohl, 1954; Correll and Johnston, 1970; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978a).

Bromus ciliatus L.

Fringed brome grass. Common in higher, drier areas. 287.

Herbaceous, often cespitose perennials of moist woods, shores, and rocky slopes. Newfoundland and Labrador to Alaska, south to California,

Mexico, Texas, Nebraska, Illinois, Tennessee, and western North Carolina (Hitchcock, 1950; Wagnon, 1952; Fernald, 1970).

Calamagrostis canadensis (Michx.) Beauv.

Bluejoint. Frequent in higher, drier areas. 279, 308.

Herbaceous, rhizomatous perennial with erect culms to one and one-half meters. Marshes, meadows, open woods, and other wet places. A circumpolar species. In North America from Newfoundland and Labrador to Alaska, south to California, New Mexico, Kansas, Kentucky, and western North Carolina (Hitchcock, 1950; Pohl, 1954; Fernald, 1970; Welsh, 1974).

Deschampsia cespitosa (L.) Beauv.

Tufted hairgrass. Local in areas along spring flows. 219, 245, 269, 281, 317.

Densely cespitose, herbaceous perennial of bogs and other wet places. A circumboreal species reaching as far south as central and South Africa and central and southern Chile. In North America from Newfoundland and Labrador to Alaska, south to mountains of California, northern Arizona and New Mexico, North Dakota, Minnesota, Wisconsin, northern Illinois, eastern West Virginia, and down the mountains to Georgia. Also reported from Greenland and Iceland (Deam, 1940; Hitchcock, 1950; Pohl, 1954; Kearney and Peebles, 1969; Munz, 1973; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978a; Martin and Hutchins, 1980).

Elymus virginicus L.

Wild-rye. Local in northeast corner of the study area with Carex stricta, Solidago sp., and other species. 521.

Erect, cespitose, perennial herb of rich thickets, moist woods, meadows, and prairies. Newfoundland and Nova Scotia to British Columbia, south to Arizona and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Voss, 1972; Scoggan, 1978a).

Glyceria stricta (Lam.) Hitch.

Fowl mannagrass. Occasional in all open areas. 201.

Herbaceous perennial with creeping and rooting bases or rhizomatous. In wet places. Newfoundland to British Columbia and Alaska, south through the 48 continuous states into Mexico. Also naturalized in Eurasia (Hitchcock, 1950; Pohl, 1954; Fernald, 1970; Welsh, 1974).

Hierochloe odorata (L.) Beauv.

Sweet grass. Rare. Plants found distantly scattered among open herbaceous vegetation. 490.

Rhizomatous perennial herb in meadows, swales, and other moist soils. A circumboreal species from southern Greenland, northern Quebec, northern Manitoba, to north of the Arctic Circle in Alaska and Mackenzie District, south to Oregon, Arizona, New Mexico, Iowa, and New Jersey (Gleason and Cronquist, 1963; Hulten, 1964; Fernald, 1970; Weimarck, 1971; Scoggan, 1978a).

Leersia oryzoides (L.) Sw.

Rice cutgrass. Rare. Only along forest's edge in very wet soil. 444.

Herbaceous perennial from creeping rhizomes. River banks, marshes, and other wet places. An amphi-Atlantic species, most common in the eastern half of North America, but the total range from Maine to eastern British Columbia, south to eastern California, northern Arizona and New Mexico, Texas, and northern Florida (Hitchcock, 1950; Pohl, 1954; Hulten, 1958; Fernald, 1970).

Muhlenbergia glomerata (Willd.) Trin.

Marsh wild-timothy. Rare. In higher drier areas of the fen. 447.

Herbaceous perennial from creeping scaly rhizomes. In swamps, sphagnum bogs, and other moist soils. Newfoundland to British Columbia, south to Nevada, Colorado, Iowa, Ohio, and Virginia (Hitchcock, 1950; Pohl, 1954).

Muhlenbergia mexicana (L.) Trin.

Mexican muhly. Frequent. Sometimes forming dense stands in higher areas of the fen. 364, 453.

Rhizomatous, herbaceous perennial of low woods, wet thickets, and open low ground. Maine to British Columbia, south to California, New Mexico, Texas, Missouri, Ohio, Virginia, and western North Carolina (Hitchcock, 1950; Pohl, 1954, 1969).

Phalaris arundinacea L.

Reed canary grass. Local. Forming dense ground cover, dominant in higher areas along the northwest shore of the lake and along the creek to the south. 222, 318.

Herbaceous perennial from creeping rhizomes along river banks, in marshes, and in other wet places. A circumboreal species, also found in Ceylon, Colombia, Iran, Israel, Italy, Java, Portugal, South Africa, and New Zealand. Introduced in all Southern Hemisphere continents except Antarctica. In North America from New Brunswick to southeastern Alaska, south to California, New Mexico, Oklahoma, Kentucky, and western North Carolina (Hitchcock, 1950; Anderson, 1961; Hulten, 1964).

Sorghastrum nutans (L.) Nash

Indian grass. Common. A dominant in some areas of Potentilla-Carex zone. 432.

Herbaceous perennial from short scaly rhizomes in prairies, open woods, and on dry slopes. Maine to southern Manitoba, south to New Mexico and eastern Arizona, northeastern Mexico, and Florida (Withrow, 1932; Hitchcock, 1950; Pohl, 1954).

Spartina pectinata Link

Prairie cordgrass. Occasional throughout higher, drier areas. 251.

Herbaceous perennial from a scaly creeping rhizome in fresh water marshes, wet prairies, and other, usually moist, soils. Nova Scotia, New Brunswick, and Anticosti Island to northeastern Alberta, south to Washington, Utah, Texas, Tennessee, and Virginia (Hitchcock, 1950; Pohl, 1954; Mobberly, 1956; Voss, 1972).

Sphenopholis obtusata (Michx.) Scribner var. major (Torr.) Erdm.

Slender wedge grass. Rare. Scattered within open herbaceous vegetation of the area. 294, 311, 326.

Slender, erect, herbaceous perennial in damp or rocky woods, edges of marshes and swamps, and other wet habitats. This species found throughout the United States and southern Canada, also one report from Alaska (Hitchcock, 1950; Pohl, 1954; Erdman, 1965).

Sporobolus heterolepis (Gray) Gray

Prairie dropseed. Rare. In dense tussocks on ant mounds on higher, drier ground just southwest of the lake. 441.

Herbaceous, erect, slender perennial in prairies and other dry soils. Quebec to eastern Saskatchewan south to eastern Colorado, eastern Texas, Arkansas, and Ohio. Rare outlier populations in Connecticut, Pennsylvania, and the mountains of North Carolina (Schaffner, 1914; Deam, 1940; Hitchcock, 1950; Pohl, 1954; Gleason and Cronquist, 1963; Steyermark, 1963; Harrington, 1964; Boivin, 1967; Radford et al., 1968; Seymour, 1969; Correll and Johnston, 1970; Fernald, 1970; Voss, 1972; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978a; Wherry, Fogg, and Wahl, 1979).

Typhaceae

Typha angustifolia L.

Narrow-leaved cat-tail. Frequent in scattered zones throughout the study area. 215.

Rhizomatous, herbaceous perennial, found predominantly in alkaline soils. A circumboreal species. In North America from Maine to Manitoba,

south to southeastern Nebraska, Missouri, and Pennsylvania. Also along Coastal Plain from Massachusetts to South Carolina. Varieties other than the typical are in North America and Eurasia and exist south of Europe in South Australia, New Zealand, South Africa, Ceylon, the Fiji Islands, the Phillipines, and other places (Hotchkiss and Dozier, 1949; Hulten, 1964; Smith, 1967; Fernald, 1970; Voss, 1972; Scoggan, 1978a).

Typha latifolia L.

Common cat-tail. Common in scattered zones throughout the study area. 514.

Rhizomatous, herbaceous perennial in marshes and shallow water. A circumboreal species, with ssp. capensis found in South Africa, and Madagascar, and ssp. latifolia reported from the Philippines. In North America subspecies latifolia is found throughout Canada and the United States, south to Guatemala (Rydberg, 1906; Hotchkiss and Dozier, 1949; Gleason and Cronquist, 1963; Steyermark, 1963; Hulten, 1964; Smith, 1967; Radford et al., 1968; Kearney and Peebles, 1969; Seymour, 1969; Correll and Johnston, 1970; Fernald, 1970; Correll and Correll, 1972; Barkley, 1977; Scoggan, 1978b; Godfrey and Wooten, 1979; Martin and Hutchins, 1980).

Liliaceae

Hypoxis hirsuta (L.) Cov.

Stargrass. Occasional in open herbaceous vegetation. 227.

An herbaceous perennial from corms. Dry open woods and meadows. Maine to Manitoba, south to Texas and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Lilium michiganense Farw.

Michigan lily. Rare. Scattered in higher, drier areas of fen. 358, 368.

Herbaceous perennial from scaly bulbs. Wet meadows and prairies, low thickets, stream borders, etc. Southern Ontario to southern Manitoba, south to Oklahoma, Arkansas, and Tennessee (Voss, 1964a; Fernald, 1970; Voss, 1972; Synge, 1980).

Polygonatum biflorum (Walt.) Ell.

Solomon seal. Rare, a few plants growing with Geranium maculatum and Symplocarpus foetidus along forest's edge in the northwest corner of the study area. 493.

Herbaceous, rhizomatous perennial in moist thickets, woods, and roadsides. New Hampshire and southern Quebec to southeastern Saskatchewan, south to New Mexico and Florida (Ownbey, 1944; Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978a).

Smilacina stellata (L.) Desf.

Starry false solomon seal. Common in Potentilla-Carex zone of the fen. 244.

Erect, herbaceous, rhizomatous perennial in thickets, open meadows, prairies, and other places with wet, sandy soil. Newfoundland to west central Mackenzie District and southern Alaska and south throughout the contiguous 48 states and into Mexico. Also naturalized in Europe (Galway, 1945; Raup, 1947a; Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Welsh, 1974; Scoggan, 1978a).

Smilax lasioneura Hooker

Carrion flower. Rare, climbing in shrub-carr. 381.

Herbaceous perennial climbing via tendrils. Alluvial soils, rich thickets, and forest borders. New York and eastern Ontario to Saskatchewan, south to Colorado, Oklahoma, and northern Florida (Gleason and Cronquist, 1963; Mangaly, 1968; Fernald, 1970).

Iridaceae

Iris virginica L. var. shrevei (Small) Anderson

Southern blue flag. Occasional in higher drier areas of herbaceous vegetation south of the lake. 228, 303.

Herbaceous perennial from more or less tuberous rhizomes in marshes, wet meadows, and swamps. Western New York and southern Ontario to Minnesota, south to northwestern Oklahoma and Arkansas, northern Alabama, and western North Carolina (Anderson, 1928; Deam, 1940; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978a; Wherry, Fogg, and Wahl, 1979). Iris virginica var. virginica is only known from the Coastal Plain from Virginia to east Texas (Anderson, 1928).

Dioscoreaceae

Dioscorea villosa L.

Wild yam. Rare. In Cornus sp. shrub-carr. 394, 407.

Rhizomatous, twining stemmed perennial of wet woods and thickets. New England to Minnesota, south to eastern Texas and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Orchidaceae

Platanthera psychodes (L.) Lindl. [Habenaria psychodes (L.) Sprengel]

Purple fringed orchid. Rare. Only found growing beneath Salix sp./Cornus sp. shrub-carr in far south end. 404.

Glabrous herbaceous perennial with a stout stem. Wet meadows, marshes, springy shores, etc. Newfoundland to Manitoba, south to Minnesota, Nebraska, Iowa, Tennessee, northern Georgia and Alabama, and western North Carolina (Gleason and Cronquist, 1963; Case, 1964; Fernald, 1970; Voss, 1972).

Liparis loeselii (L.) Richard

Fen orchid. Rare. Scattered among sparser vegetation along lake's shore. 246.

Herbaceous perennial from tubers or bulbs. Peaty meadows, bogs, springy areas, etc. An amphi-Atlantic species. In North America from Nova Scotia and the Gaspe Peninsula to Saskatchewan, south to Nebraska, Missouri, northern Alabama, and Maryland; once collected from Klickitat County, Washington (Hulten, 1958; Gleason and Cronquist, 1963; Case, 1964; Fernald, 1970; Voss, 1972; Hitchcock and Cronquist, 1973).

Spiranthes cernua (L.) Richard

Nodding ladies'-tresses. Frequent along low, sparsely populated mud flats along creek in south end. 427.

Herbaceous perennial from tuberous, thickened roots. Woods, fields, bogs, low thickets, and other such places. Nova Scotia to Minnesota and North Dakota, south to eastern Texas and Florida (Gleason and Cronquist, 1963; Case, 1964; Fernald, 1970).

Magnoliopsida

Lauraceae

Lindera benzoin (L.) Blume var. benzoin

Spice bush. Local, forming small dense stands on higher elevations. 397, 483.

Aromatic much branched shrub to five meters. In rich moist woods. Southern Maine to Michigan, southeastern Kansas, Kentucky, and the mountains of Georgia (Gleason and Cronquist, 1963; Fernald, 1970).

Sassafras albidum (Nutt.) Nees

Sassafras. Rare, a single tree (3m) on sandy soil of the abandoned roadbed at the outlet creek. 494.

A shrub or tree to 40 meters in dry or rich woods, thickets, old fields, and roadsides. Southwestern Maine and southern Ontario to southern Michigan, south to eastern Texas and northern Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Ranunculaceae

Caltha palustris L. var. palustris

Marsh marigold. Frequent through entire study area. 248, 492.

Herbaceous perennial with hollow stems. Swamps, wet meadows, wet woods, and other similar places. A circumboreal species. In North America from Newfoundland and Labrador to Alaska, south to Nebraska, Illinois, Indiana, and the mountains of Tennessee, and North and South Carolina (Parker, 1936; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977).

Clematis virginiana L.

Virgin's bower. Local. Along outlet creek and in open shrub carr vegetation in south end. 353.

A half-woody climber of low, moist ground. The Gaspe Peninsula, Nova Scotia to Manitoba, south to eastern Nebraska and Kansas, Louisiana and northern Florida (Gleason and Cronquist, 1963; Duncan, 1967; Fernald, 1970; Barkley, 1977).

Ranunculus abortivus L. var. abortivus

Small flowered crowfoot. Rare along forest's edge in area dominated by Symplocarpus foetidus. 505.

Erect fibrous rooted herb of moist or dry thickets, clearings, and low woods. Labrador to southwestern Mackenzie District and south central Alaska, south to Washington, Colorado, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978b).

Ranunculus recurvatus Poir.

Hooked crowfoot (Britton, 1901). Rare at forest's edge with Symplocarpus foetidus. 506.

Herbaceous perennial from a short, thick, corm-like rhizome. Dry to moist creek-edges and woods. Newfoundland and southern Quebec to Minnesota and southeastern North Dakota, south to eastern Nebraska, eastern Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Scoggan, 1978b).

Thalictrum dasycarpum Fisch. & Ave-Lall.

Meadow rue. Rare in higher drier areas. 232.

Herbaceous perennial from a stout caudex. Wet meadows, swamps and other moist soils. Ontario to Alberta, south to Washington, Arizona, Louisiana, Illinois, and Ohio (Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977).

Berberidaceae

Podophyllum peltatum L.

May apple. Rare. With Pteridium aquilinum beneath forest canopy along northwest side of the lake. 255.

Rhizomatous, herbaceous perennial with thick fibrous roots in rich woods, pastures, and thickets. Quebec to Minnesota, south to Texas and Florida (Gleason and Cronquist, 1963; Mitchell, 1963; Fernald, 1970; Barkley, 1977).

Ulmaceae

Ulmus americana L.

American elm. Rare. Small trees (5 to 10 meters) scattered at highest elevations of the area. 223.

Tree to forty meters with smooth, short hairy twigs, usually in moist soil. Cape Breton Island and Nova Scotia to southeastern Saskatchewan, south to eastern Texas and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Urticaceae

Boehmeria cylindrica (L.) Sw.

False nettle. Rare in very wet soil near forest's edge. 259, 290.

Dioecious or polygamodioecious, herbaceous perennials, which lack stinging hairs. Moist soil. Maine, southern Quebec and Ontario, south to New Mexico, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Bassett et al., 1974; Barkley, 1977).

Pilea pumila (L.) Gray

Clearweed. Local. In water saturated soil at forest's edge. 387.

Herbaceous annual with translucent leaves and stem. Shaded, moist, rich areas. Prince Edward Island and New Brunswick to Ontario, south to North Dakota, Texas, Louisiana, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Bassett et al., 1974; Barkley, 1977).

Urtica dioica L. ssp. gracilis (Ait.) Selander. [Urtica dioica L. var. procera (Muhl.) Wedd.]

Stinging nettle. Rare. Only growing in wetter soil near forest's edge. 313.

Erect herbaceous perennial. Moist thickets and roadsides. A circumboreal species in part introduced to North America. Subspecies gracilis is amphi-Atlantic and found in North America from Newfoundland and Labrador to Alaska, south to central California, Idaho, Wyoming, eastern Arizona, New Mexico, Indiana, and Virginia (Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Woodland, 1982).

Santalaceae

Comandra umbellata (L.) Nutt.

Bastard toadflax. Rare, growing with Sphagnum sp. and Carex stricta in high area southwest of the lake. 512.

Rhizomatous, erect, herbaceous perennial of upland woods, prairies, and shores. The species ranges from Newfoundland and west central Manitoba to north of the Arctic Circle in Mackenzie District and southcentral Yukon, south to Oregon, Arizona, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978b).

Juglandaceae

Carya glabra (Mill.) Sweet

Pignut hickory. Rare, a single fallen tree from forested slope. 285.

Tree with gray bark becoming furrowed at maturity. Dry uplands. Southern New Hampshire to southern Michigan and Illinois, south to Louisiana and the northern half of peninsular Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Fagaceae

Quercus rubra L.

Red oak. Rare in high dry areas with scattered shrub-carr in south end of study area. 395.

Tree with hard deeply furrowed bark of dry upland woods. Cape Breton Island to Quebec and Minnesota, south to eastern Nebraska, eastern Oklahoma, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Quercus velutina Lam.

Black oak. Rare. A couple of seedlings in the Potentilla-Carex zone along the northwest side of the lake. 274.

Tree with very dark rough outer bark and yellow/orange inner bark, usually in dry upland soils. Southern Maine to southern Minnesota, south to southeastern Nebraska, eastern Texas, and northern Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1977).

Betulaceae

Betula pumila L. var. glandulifera Regel

Swamp-birch. Local. In scattered dense patches in drier areas south of lake. 341.

Erect or prostrate shrub with glandular leaves and branchlets. Often in calcareous areas, bogs, and wooded swamps. Northeastern Quebec to Alaska and the Yukon, south to Montana, North Dakota, northern Iowa, northern Illinois, northern Indiana, and Ohio; also, reported from Nova Scotia (Parker, 1936; Thompson, 1939; Hounsell and Smith, 1966; Fernald, 1970; Scoggan, 1978b).

Corylus americana Walt.

American hazel-nut. Local in dense thicket in Carex-Amphicarpaea zone of fen. 309, 413.

Shrub of up to three meters of dry or moist woods and thickets. Maine to Saskatchewan, south to northeastern Oklahoma, Arkansas, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Caryophyllaceae

Cerastium fontanum Baumg.

Common mouse ear. Rare, along dock path and inlet creek. 509.

Matted herbaceous perennial of lawns, fields, and roadsides. A native of Eurasia now naturalized throughout our region (Gleason and Cronquist, 1963; Fernald, 1970).

Dianthus armeria L.

Deptford-pink. Rare. Only found along path leading to the lake. 367.

Herbaceous biennial or perennial of dry fields and roadsides. This species naturalized from Europe. From Nova Scotia to British Columbia, south to Oklahoma and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977), also found in California (Munz, 1973).

Stellaria longifolia Muhl.

Long-leaved stitchwort (Britton, 1901). Local, in open herbaceous vegetation. Rabeler 729.

Weak stemmed, herbaceous perennial of damp thickets, meadows and shores. A circumboreal species, found in North America from Newfoundland and Nova Scotia to northern Manitoba, Mackenzie District, and Alaska, south to California, Arizona, Louisiana, and South Carolina (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978b).

Polygonaceae

Polygonum amphibium L. var. stipulaceum N. Coleman

Water smartweed. Rare. Found only at north end near lake's outlet. 482.

Herbaceous perennial from tough forking stolons and rhizomes. A terrestrial or aquatic species, found from Newfoundland to British Columbia, south to California, Missouri, Indiana, and New Jersey (Gleason and Cronquist, 1963; Fernald, 1970).

Polygonum sagittatum L.

Tear-thumb. Rare. Few plants on edge of shrub-carr in south end of area. 486.

Reclining herbaceous annual, retrorsely prickly. Marshes, wet meadows, and other low grounds. Newfoundland to Saskatchewan, south to Texas and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Rumex obtusifolius L.

Bitterdock. Rare. In wet areas along forest's edge. 286.

Herbaceous perennial of shores, streambanks, and waste places. Naturalized from Europe and distributed from Quebec and Nova Scotia to British Columbia, south to Arizona and Florida. Beyond North America and Eurasia, this species occurs in South Africa, Java, Central and South America, Mexico, Cuba, New Zealand, and Australia (Trelease, 1892; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971).

Rumex orbiculatus Gray

Great water dock. Rare. In open wet areas next to forest's edge. 408, 485.

Stout herbaceous perennial of swamps, wet meadows, and shores. Newfoundland to North Dakota, south to Nebraska, Illinois, Ohio, and New Jersey (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Clusiaceae

Hypericum kalmianum L.

Kalm's St. John's wort. Rare, within and bordering shrub-carr near outlet of lake. 376.

Branching shrub to one meter in calcareous or more often sandy, moist soils. Extreme southern Quebec to Wisconsin, south to Illinois, Indiana, and Ohio (i.e., plant chiefly of the Great Lakes region) (McLaughlin, 1931; Deam, 1940; Gleason and Cronquist, 1963; Guire and Voss, 1963; Fernald, 1970; Mohlenbrock and Ladd, 1978; Wherry, Fogg, and Wahl, 1979).

Hypericum perforatum L.

Common St. John's wort. Rare. Found only in far south and along creek. 304.

Herbaceous, perennial weed in fields, meadows, etc. Native of Europe, naturalized throughout much of the United States and southern Canada (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Hypericum punctatum Lam.

Spotted St. John's wort. Rare in area dominated by Carex stricta and Potentilla fruticosa in south end of study area. 416.

Herbaceous perennial with pelucid dot-covered foliage, etc. Moist or dry soil in thickets, borders of woods, and other similar places. Southern Quebec and Ontario to Minnesota, south to eastern Oklahoma, Mississippi, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Violaceae

Viola nephrophylla Greene

Northern bog violet (Martin and Hutchins, 1980). Common in much of the open herbaceous vegetation. 489.

Herbaceous, acaulescent perennial from a stout rhizome. Often in calcareous soils of shores, bogs, and open low ground. Newfoundland to north central Manitoba, and northwestern Mackenzie District, south to southern California, New Mexico, Iowa, Michigan, and Connecticut (Deam, 1940; Peck, 1961; Gleason and Cronquist, 1963; Russell and Crosswhite, 1963; Russell, 1965; Fernald, 1970; Munz, 1973; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1978b).

Salicaceae

Populus tremula L. ssp. tremuloides (Michx.) Loeve & Loeve [Populus tremuloides Michx.]

Trembling aspen. Local. Encroaching into herbaceous vegetation in higher areas near forest's edge. 224.

Tree to 20 meters with smoothish bark in dry or moist soil. A circumboreal species. This subspecies in North America from Newfoundland and Nova Scotia to Alaska, southern Iowa, Indiana, West Virginia, and New Jersey. Also south through the western United States in progressively smaller, more scattered populations into Mexico (Raup, 1947a, b; Little, 1953, 1971; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971).

Salix bebbiana Sarg.

Beaked willow. Local. Mixed with other species of Salix and Cornus to form dense shrub-carr stands. 268, 276, 343.

Small tree or shrub with brown or gray furrowed bark in wet or moist places. Newfoundland; Labrador, and Nova Scotia to Alaska, south to Arizona, New Mexico, northwestern Nebraska, Iowa, northern Indiana and Ohio, Pennsylvania, and New Jersey (Raup, 1947a; Gleason and Cronquist, 1963; Fernald, 1970; Little, 1976).

Salix discolor Muhl.

Pussy-willow. Frequent. In combination with other species of Salix and Cornus, forming dense shrub-carr stands. 247, 267, 329, 363, 398, 464, 467, 474.

Small tree or large shrub up to six meters in damp thickets and often in swamps. Southern Labrador and Prince Edward Island to British Columbia, south to Idaho, northern Wyoming, Iowa, northeastern Missouri, northeastern Tennessee, and northern New Jersey (Little, 1953, 1976; Fernald, 1970).

Salix exigua Nutt. ssp. interior (Rowlee) Cronq. [Salix interior Rowlee]

Sandbar-willow. Local, on sandy soil of abandoned roadbed along outlet creek, trees to three meters. 349.

Stoloniferous colonial shrub to six meters on sandbars and alluvial soils. New Brunswick to northern Alaska and Mackenzie District, south to California, Texas, Louisiana, and Virginia (Scoggan, 1957, 1978b; Gleason and Cronquist, 1963; Fernald, 1970).

Salix petiolaris Sm.

Slender willow. Local as part of shrub-carr on sandy soil of abandoned roadbed along outlet creek. 466.

Shrub or tree in meadows, stream banks, and shores. New Brunswick and Quebec, to northeastern Alberta and central British Columbia, south to Colorado, northern Nebraska, Minnesota, Michigan, and Connecticut, also sporadic in Virginia and Oklahoma (Scoggan, 1957; Gleason and Cronquist, 1963; Fernald, 1970).

Salix rigida Muhl.

Heart-leaved willow. Local. In shrub-carr areas near the lake's outlet. 390, 468.

Shrub of up to four meters in stream banks, thickets, and other low places. Newfoundland to Saskatchewan, south to Montana, Kansas, Mississippi, and Virginia (Gleason and Cronquist, 1963; Fernald, 1970).

Salix sericea Marsh.

Silky willow. Local. Small trees to two meters along creek in south end of study area. 300, 328.

Shrub to four meters in low thickets and other moist grounds, often near running water. Nova Scotia to Quebec, and Wisconsin, south to Iowa, Missouri, northern Georgia, and North Carolina (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1977).

Brassicaceae

Barbarea vulgaris R. Br. var. vulgaris

Yellow rocket. Rare, along inlet creek in herbaceous vegetation. 508.

Herbaceous biennial on damp soil of fields, roadsides, and meadows. A native of Europe which has been naturalized in southern Greenland, all of the Canadian Provinces except Saskatchewan, and in the United States from Maine to eastern North Dakota, south to Oklahoma and Georgia (Gleason and Cronquist, 1963; Muessel et al., 1965; Radford et al., 1968; Fernald, 1970; Barkley, 1977).

Cardamine bulbosa (Schreb.) BSP

Spring-cress. Occasional within herbaceous vegetation. 488.

Herbaceous perennial from a short thick tuberous root. In meadows, wet woods, or shallow water. Southern New Hampshire and Quebec to southeastern Manitoba, south to eastern South Dakota, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1978b).

Nasturtium officinale R. Br.

Water-cress. Abundant in many of the spring flows. 206, 510.

Perennial herb with floating, submerged, or creeping stems. A subatlantic native of Eurasia, but now established in brooks,

springheads, and cool waters throughout the United States and Canada. Also naturalized in central and eastern tropical Africa, Madagascar, South Africa, Bolivia, Argentina, Australia, and many other places (Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971).

Primulaceae

Lysimachia quadriflora Sims.

Four-flowered loosestrife. Frequent in Eleocharis-Scirpus zone near transition to Potentilla-Carex zone of fen. 320, 357.

Herbaceous perennial of calcareous bogs, swales and other wet soil, open areas. Massachusetts to Manitoba, south to Arkansas, northern Mississippi, and Georgia (Ray, 1956; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Lysimachia thyrsiflora L.

Tufted loosestrife. Occasional in fen areas dominated by Carex stricta and Potentilla fruticosa. 211.

Herbaceous perennial from creeping rhizomes. In swamps, bogs, and marshes. A circumboreal species, in North America from Prince Edward Island and Nova Scotia to northwestern Mackenzie District and Alaska, south to California, Colorado, Missouri, and West Virginia (Ray, 1956; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977; Scoggan, 1979).

Grossulariaceae

Ribes missouriense Nutt.

Missouri gooseberry. Rare. Few individuals in areas of higher, drier, fen vegetation. 282.

Shrub with stout, often long spines. In moist or dry open woods or thickets. Rare in the East. Connecticut to Tennessee, west to eastern Montana, and Oklahoma (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Saxifragaceae

Parnassia glauca Raf.

Grass of Parnassus. Occasional in higher fen areas. 445.

Herbaceous perennial of wet meadows and calcareous soils. Newfoundland to Saskatchewan, south to South Dakota, Illinois, Ohio, and Virginia (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Saxifraga pensylvanica L. ssp. pensylvanica var. pensylvanica

Swamp saxifrage. Rare, a few plants at forest's edge in shrub-carr opening in northeast corner of the area. 504.

Herbaceous perennial from a thick rhizome. Wet meadows, swamps, boggy thickets, and prairies. Maine to Minnesota, south to Illinois, and Virginia (Burns, 1942; Gleason and Cronquist, 1963; Steyermark, 1963; Fernald, 1970; Scoggan, 1978b).

Rosaceae

Amelanchier canadensis (L.) Medic

Serviceberry. Rare. On edge of Prunus serotina and Rubus sp. thicket southwest of lake. 293, 396.

Shrub forming clumps in swamps, thickets, and other low ground habitats. A chiefly Coastal Plain species, Newfoundland to Mississippi and inland to Quebec and New York (Gleason and Cronquist, 1963; Fernald, 1970).

Filipendula rubra (Hill) Robbins

Queen-of-the-prairie. Rare. Found only in vegetative condition growing beneath Cornus shrub-carr along northwest corner of the lake. 481.

Herbaceous perennial of low woods and wet prairies or meadows. Pennsylvania to Minnesota, south to Iowa, Illinois, Kentucky, North Carolina, and Georgia. Also, cultivated and escaped in New England (Gleason and Cronquist, 1963; Fernald, 1970; Godfrey and Wooten, 1981).

Fragaria virginiana Duchesne

Wild strawberry. Rare, plants only on the sandy soil of the abandoned roadbed at the outlet creek. 496.

Herbaceous perennial producing runners from a caudex. Fields and edges of woods. Newfoundland and Labrador to northern Mackenzie District and central Alaska, south to Colorado, Oklahoma and Louisiana (Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Scoggan, 1978b).

Geum aleppinum Jacq. var. strictum (Ait.) Fern.

Avens. Occasional in higher, drier areas. 288.

Herbaceous perennial of thickets, meadows, and swamps. A circumboreal species. In North America from Nova Scotia to south central Alaska, south to California and east to the Rocky Mountains; Alberta to New Mexico and Mexico, east to Kansas, Iowa, Illinois, West Virginia, and New Jersey (Gleason and Cronquist, 1963; Porsild, 1966; Fernald, 1970; Hulten, 1971; Hitchcock and Cronquist, 1973; Welsh, 1974; Barkley, 1977).

Potentilla fruticosa L.

Shrubby cinquefoil. Abundant in higher, drier areas. 233.

A shrub to one meter, of wet meadows, shores, and especially in calcareous soils. A circumboreal species, rare in western Eurasia. In North America it is found from Newfoundland, Labrador, and Nova Scotia to Alaska, south to California, New Mexico, southern Iowa and Illinois, Indiana, and New Jersey. Also reported from Tennessee and has been introduced to South Africa (Raup, 1947a, b; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977).

Potentilla simplex Michx.

Old-field cinquefoil. Rare, only on the sandy soil of the abandoned roadbed at the outlet creek. 498.

Perennial herb from a short, irregularly enlarged rhizome. Dry or moist woods, fields, and thickets. Newfoundland to Minnesota, south to Texas, Alabama, and South Carolina (Gleason and Cronquist, 1963; Fernald, 1970).

Prunus serotina Ehrh.

Black cherry. Rare, but some individuals to 15 meters in height in highest areas, where many woody (tree) species have successfully encroached. 291.

Tree to 30 meters with dark brown outer bark and twigs with aromatic inner bark. Dry woods, roadsides, waste lands, and forest margins (Gleason and Cronquist, 1963; Fernald, 1970). Nova Scotia to New Brunswick to Minnesota, south to Texas and northern Florida. Scattered in New Mexico and Arizona, then south through Mexico to Guatemala (Little, 1953, 1971).

Rosa multiflora Thunb.

Many-flowered rose. Local in shrub-carr along northwest side of lake. 231.

Trailing, arching shrub. Borders of woods, clearings, and roadsides. A native of east Asia escaped from cultivation in North America from southern New England to southwestern Iowa, eastern Kansas and south through the United States (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Rosa palustris Marsh.

Swamp rose. Local in shrub-carr of the area. 354.

Rhizomatous, highly branched shrub with stout prickles in swamps, marshes, and other wet places. Nova Scotia and New Brunswick to Minnesota, south to the Gulf of Mexico (Gleason and Cronquist, 1963; Fernald, 1970).

Rubus allegheniensis Porter

Common blackberry. Local. Scattered stands throughout the area. 214.

Erect or high-arching shrubby perennial in dry clearings and thickets. Newfoundland to Minnesota, south to Oklahoma, Arkansas, Tennessee, and the mountains of North Carolina (Bailey, 1941; Barkley, 1977).

Rubus occidentalis L.

Black raspberry. Local. Scattered clumps in some shrub-carr areas. 252, 260.

Perennial with erect or arching stems bearing sparse prickles with an expanded base. Rich thickets, fields, and borders of woods. New Brunswick and southern Quebec to North Dakota, south to eastern Colorado, Oklahoma, Arkansas, and northern Georgia (Bailey, 1941; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Rubus strigosus Michx.

Red raspberry. Local. Scattered clumps in association with some shrub-carr areas. 338, 374.

Perennial with dense population of slender-based prickles and stiff bristles on erect, spreading or decumbent stems. Dry to moist woods, thickets, clearings, and fields. Nova Scotia, Newfoundland, and Labrador to Alaska, south to California, New Mexico, Nebraska, Iowa, Tennessee, and North Carolina (Bailey, 1941; Raup, 1947a; Gleason and Cronquist, 1963; Fernald, 1970).

Spiraea alba DuRoi

Meadow sweet. Local. In small clumps in northwest corner of area. 382.

Erect shrub to two meters of wet meadows, swamps, and other low ground. Northern Vermont to Alberta, south to South Dakota, Missouri, Illinois, Ohio, and highlands of North Carolina (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Spiraea tomentosa L.

Hardhack. Local, in clumps scattered throughout higher, drier areas. 411.

Sparsely branched shrub to one meter in swamps, pastures, and wet meadows. Prince Edward Island and Nova Scotia to Minnesota, south to Arkansas, Tennessee, South Carolina, and North Carolina (Parker, 1936; Thompson, 1939; Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Godfrey and Wooten, 1981).

Fabaceae

Amphicarpaea bracteata (L.) Fern.

Hog peanut. Common in areas of vegetation along forest's edge. 250, 270, 435.

Twining annual herbs, glabrous to pubescent in woods and thickets. Nova Scotia and New Brunswick to Manitoba, south to Texas and Florida (Gleason and Cronquist, 1963; Turner and Fearing, 1964; Correll and Johnston, 1970; Fernald, 1970; Barkley, 1977; Scoggan, 1978b). Two collections also reported from Mount Orizaba, Mexico (Turner and Fearing, 1964).

Apios americana Medic.

Ground-nut. Common in vegetation zones along forest's edge. 271.

Herbaceous perennial with alternately constricted and tuberously enlarged rootstocks. Moist, rich thickets and woods. Nova Scotia and Newfoundland to Minnesota, south to Colorado, Texas, and Florida (Fassett, 1939; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Lathyrus palustris L. var. myrtifolius (Muhl.) Gray.

Vetchling. Frequent throughout region. 209, 239.

Climbing, rhizomatous, herbaceous perennial of wet meadows, swamps, and other moist places. A species of circumboreal distribution in the Northern Hemisphere. This variety from Quebec to Manitoba, south to Colorado, Arkansas, Tennessee, and western North Carolina (White, 1894; Fernald, 1911, 1970; Thompson, 1939; Gleason and Cronquist, 1963; Hulten, 1971; Barkley, 1977).

Lythraceae

Lythrum salicaria L. var. tomentosum (DC.) DC.

Purple loosestrife. Scattered throughout fen vegetation. 355.

Stout herbaceous perennial of marshes, wet meadows, river floodplains, etc. Introduced in North America from Newfoundland and Nova Scotia to southeastern British Columbia, south to northern California, eastern Texas, Tennessee, and North Carolina (Gleason and Cronquist, 1963; Fernald, 1970; Stuckey, 1980).

Onagraceae

Circaea lutetiana L. ssp. canadensis (L.) Aschers. & Magnus [Circaea quadrisulcata (Maxim.) Franch & Savat.]

Enchanter's nightshade. Rare. Found growing with Podophyllum peltatum and Pteridium aquilinum beneath forest canopy along northwest side of lake. 359.

Rhizomatous, perennial herb with filiform stolons. Rich, moist woods, thickets, and ravines. An amphi-Atlantic species in North America from Nova Scotia, New Brunswick, and Quebec to North Dakota, south to Oklahoma, Tennessee, and southern Georgia (Gleason and Cronquist, 1963; Doyon and Lavoie, 1966; Fernald, 1970; Barkley, 1977).

Epilobium ciliatum Raf.

Willow herb. Rare in higher, drier areas. 480.

Perennial herb with fibrous roots from short rhizomes. Many types of wet places. Newfoundland and Labrador to Alaska, south to southern California, New Mexico, northern Iowa, northern Illinois, and Virginia (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Epilobium strictum Muhl.

Downy willow herb. Local in open herbaceous vegetation south of the lake. 418.

Herbaceous perennial from slender rhizomes in bogs, meadows, and swamps. The Gaspe Peninsula and Nova Scotia to Minnesota, south to Illinois, Ohio, and Virginia (Trelease, 1891; Gleason and Cronquist, 1963; Fernald, 1970).

Cornaceae

Cornus florida L.

Flowering dogwood. Rare, represented only by individuals of the upland forest whose lower branches interingle with the vegetation of the Carex-Amphicarpaea zone. Stoynoff (pers. observ.).

Widely branched, large shrub or tree to 10 meters. In woods from Maine to southern Ontario and Michigan, south to Kansas, northeastern Mexico and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Cornus foemina Mill. ssp. racemosa (Lam.) Wilson [Cornus racemosa Lam.]

Gray dogwood. Abundant throughout areas of higher, drier elevation. 203, 242, 375, 391.

Shrub of one to five meters forming thickets on roadsides, streambanks, and other areas with moist soils. Maine to Manitoba, south to Oklahoma, Arkansas and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1977).

Cornus stolonifera Michx.

Red osier dogwood. Abundant throughout areas of higher, drier elevation. 212.

A shrub to three meters of streambanks and moist woods (Gleason and Cronquist, 1963). Southern Labrador to southwestern Mackenzie District and central Alaska, south to California, Arizona, New Mexico, Nebraska, Illinois, West Virginia, and Pennsylvania. Also, isolated populations in northern Mexico (Rickett, 1944; Raup, 1947a, b; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Little, 1976, 1977).

Rhamnaceae

Rhamnus alnifolia L'Her

Alder-leaved buckthorn. Local in areas south of the lake. 360.

Low shrub of swamps, meadows, low woods, and often in calcareous places. Eastern Cascade range of British Columbia to northern California, east through northern Alberta to Newfoundland and Nova Scotia and east in the United States to Wyoming, Iowa, northern Illinois and Indiana, West Virginia, and New Jersey (Scoggan, 1957, 1978b; Gleason and Cronquist, 1963; Fernald, 1970; Hitchcock and Cronquist, 1973; Barkley, 1977).

Vitaceae

Parthenocissus quinquefolia (L.) Planch.

Virginia creeper. Rare. Found only beneath Toxicodendron vernix northwest of lake. 515.

Climbing, woody vine in moist soils. Maine and southwestern Quebec to Minnesota, south to Texas and Florida (Trelease, 1891; Gleason and Cronquist, 1963; Duncan, 1967; Fernald, 1970; Barkley, 1977).

Aceraceae

Acer rubrum L. var. rubrum

Red maple. Rare. A few small (to seven meters) trees scattered along forest's edge and edges of shrub-carr. 292.

Medium sized tree to 35 meters, of swamps or moist uplands. Nova Scotia and southern Quebec to extreme southeastern Manitoba, south to Minnesota, Wisconsin, Indiana, southeastern Missouri, eastern Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Little, 1971).

Anacardiaceae

Rhus copallinum L.

Dwarf or shining sumac. Rare. Found only in Potentilla-Carex zone of fen along northwest side of lake. 347, 519.

Shrub or small tree of dry woods and openings (Fernald, 1970). Maine, New Hampshire, and Vermont, to Florida, west to eastern Texas, Oklahoma, Nebraska, and Wisconsin (Barkley, 1937; Barkley, 1977; Little, 1977).

Rhus typhina L.

Staghorn-sumac. Rare. Found only in Potentilla-Carex zone of fen along northwest side of lake. 516.

Shrub or small tree of dry soils (Fernald, 1970). Cape Breton Island and Nova Scotia to mountains of North Carolina, Georgia, and Alabama, west to Illinois, Iowa, and Minnesota (Barkley, 1937; Barkley, 1977; Little, 1977).

Toxicodendron radicans (L.) Kuntze ssp. negundo (Greene) Gillis

Poison ivy. Rare. Found near forest's edge in fen along northwest side of lake. 272.

Vine or shrub with aerial roots (Gillis, 1971). The species widespread throughout southern Canada, the United States, and Mexico. This variety is found from New York to the mountains of Virginia, west to southeastern Texas, Nebraska, and Minnesota (McNair, 1925a; Gillis, 1971; Barkley, 1977).

Toxicodendron vernix (L.) Kuntze

Poison sumac. Occasional throughout the study area. Stoynoff (pers. observ.).

Shrub of swamp-like areas (Gleason and Cronquist, 1963). Maine to Maryland, west to Illinois, Wisconsin, and Minnesota; Virginia to Florida and west to eastern Tennessee and eastern Texas (McNair, 1925b; Little, 1977).

Geraniaceae

Geranium maculatum L.

Wild geranium. Local, at edge of forest in open herbaceous cover. 491.

Erect, herbaceous perennial from a stout rhizome in meadows, thickets, and woodlands. Maine to southern Ontario, southern Quebec and Minnesota, south to Arkansas and Georgia (Gleason and Cronquist, 1963; Martin, 1965; Fernald, 1970; Scoggan, 1979).

Balsaminaceae

Impatiens capensis Meerb. [Impatiens biflora Wal.]

Touch-me-not. Local. Only in wetter soils near forest's edge, often with Pilea pumila and Leersia oryzoides. 402, 437.

Herbaceous annual of moist woods and springy places. Newfoundland to British Columbia, south to Oregon, Oklahoma, Alabama, and Florida (Scoggan, 1957, 1978; Gleason and Cronquist, 1963; Ornduff, 1967; Fernald, 1970; Barkley, 1977).

Apiaceae

Angelica atropurpurea L.

Dark purple alexanders. Local. Found in Carex-Amphicarpaea zone of fen along northwest side of lake. 332.

Stout perennial herb of moist, rich soils. Labrador and Newfoundland to Maryland and Delaware, west to Illinois and Minnesota (Mathias and Constance, 1944; Fernald, 1970).

Berula erecta (Huds.) Cov. var. incisum (Torr.) Cronq.

Water-parsnip. Local. Found in area dominated by Eleocharis rostellata along northeast shore of lake. 352, 401.

Stoloniferous, perennial herb of springy and boggy environments. New York to British Columbia, south to Florida, Oaxaca, and Baja California (Mathias and Constance, 1944; Gleason and Cronquist, 1963; Barkley, 1977).

Cicuta bulbifera L.

Water hemlock. Rare. Scattered throughout study area. 330.

Poisonous, perennial herb from tuberous roots. Swamps and wet thickets. Labrador and Newfoundland to northern Alberta and Manitoba, and British Columbia (with an isolated report in the central Mackenzie District), south to Oregon, Nebraska, and Virginia (Mathias and Constance, 1942; Scoggan, 1957, 1979; Lepage, 1966; Fernald, 1970; Barkley, 1977).

Cicuta maculata L. var. maculata

Water hemlock. Rare in southern half of study area within Carex stricta dominated vegetation. 479.

Poisonous, herbaceous perennial with tuberous thickened roots. Swamps, meadows, low thickets, and various other areas. Nova Scotia and the Gaspe Peninsula to Manitoba, south to Wyoming, Mexico, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Osmorhiza claytoni (Michx.) C.B. Clarke

Sweet cicely. Rare, beneath Cornus shrub-carr in northeast corner of the wetland. 502.

Herbaceous perennial from thickened aromatic roots in moist woods. Newfoundland to southern Ontario and Minnesota, south to eastern South Dakota, eastern Kansas, Arkansas, northeastern Georgia, the mountains of North Carolina, and the Piedmont of South Carolina (Constance and Shan, 1948; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Scoggan, 1979).

Oxypolis rigidior (L.) Raf.

Cowbane. Scattered throughout the study area. 417.

Poisonous, perennial herb from clustered, fusiform roots. Swamps, marshes, and other wet places. Minnesota to New York, south to Florida and Texas (Mathias and Constance, 1944; Gleason and Cronquist, 1963; Fernald, 1970).

Zizia aurea (L.) Koch.

Golden alexanders. Frequent in Potentilla-Carex zone of fen. 235.

Perennial herb from clustered, thickened roots. Meadows, damp thickets, and other wet places (Fernald, 1970). New Brunswick and Nova Scotia to Saskatchewan, south to east Texas and Florida (Mathias and Constance, 1944; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Gentianaceae

Gentiana andrewsii Griseb.

Closed gentian. Frequent throughout drier areas. 454.

Herbaceous perennial from a stout caudex and long, coarse roots. Locally in New England to Saskatchewan, south to Nebraska, Arkansas, Georgia, and western North Carolina (Gleason and Cronquist, 1963; Pringle, 1967; Fernald, 1970; Barkley, 1977).

Gentianopsis virgata (Raf.) Holub [Gentiana procera Holm.]

Purple fringed gentian. Common throughout drier areas of open herbaceous vegetation. 446.

Annual or biennial herb of bogs, meadows, and, especially, calcareous habitats (Gleason and Cronquist, 1963). Western New York to southern Mackenzie District and Alberta, south to western North Dakota and northern Montana, Iowa, and Ohio (Gillett, 1957; Gleason and Cronquist, 1963; Iltis, 1965).

Apocynaceae

Apocynum sibiricum Jacq. var. *sibiricum*

Prairie dogbane. Local in area southwest of lake, otherwise scattered. 336.

Perennial herb of rocky or gravelly soil. Newfoundland to southern Mackenzie District and British Columbia, south to northern Texas, Missouri, Indiana, and Virginia (Scoggan, 1957; Fernald, 1970; Barkley, 1977).

Asclepiadaceae

Asclepias incarnata L. var. *incarnata*

Swamp milkweed. Occasional in fen and throughout the study area. 324.

Perennial herb from short rootstocks. Swamps, thickets, and other wet places. Nova Scotia to Manitoba, south to Utah, New Mexico, Texas, and Florida (Woodson, 1954; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Asclepias syriaca L.

Common milkweed. Occasional within study area. 327.

Perennial herb with a stout stem, from creeping rhizomes. Thickets, meadows, and roadsides. New Brunswick to Saskatchewan, south to Oklahoma, Arkansas, Tennessee, Georgia, and North Carolina (Deam, 1940; Woodson, 1954; Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1979; Wherry, Fogg, and Wahl, 1979). Native of North America and introduced to southern Europe (Fernald, 1970).

Solanaceae

Solanum dulcamara L.

Bittersweet. Rare. Located in a few places near forest's edge. 257.

Woody, rhizomatous, perennial climber of thickets, clearings, and open woods, often in moist soils. A circumpolar species native to Eurasia, introduced and naturalized through North America (Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977).

Convolvulaceae

Calystegia sepium (L.) R.Br. [Convolvulus sepium L.]

Hedge-bindweed. Frequent. Scrambling over vegetation of Potentilla-Carex zone. 213, 238.

Herbaceous twining perennial of shores, thickets, and disturbed sites. Found throughout temperate regions of North America and Eurasia, with native and introduced forms in North America (Gleason and Cronquist, 1963).

Cuscutaceae

Cuscuta cephalanthi Engelm.

Dodder. Rare. Found only in shrub-carr in south end of study area. 469.

A parasitic, coarse, yellow, twining, herbaceous annual of low ground on various herbs and shrubs. Nova Scotia to British Columbia [excluding New Brunswick, Quebec, Ontario, and Saskatchewan (Scoggan, 1979)], south to Oregon, New Mexico, and north Texas, less frequently south to Mexico (Yuncker, 1932; Gleason and Cronquist, 1963; Fernald,

1970; Correll and Correll, 1972; Barkley, 1977; Scoggan, 1979; Godfrey and Wooten, 1981).

Polemoniaceae

Phlox pilosa L. ssp. pilosa

Downy phlox. Frequent throughout Potentilla-Carex zone. 204, 275.

Herbaceous perennial of open dry woods, prairies, sandhills, etc. Connecticut to Wisconsin, south to eastern Iowa, Texas, and Florida (Gleason and Cronquist, 1963; Levin and Smith, 1966; Levin, 1968; Radford et al., 1968; Correll and Johston, 1970; Fernald, 1970; Barkley, 1977).

Verbenaceae

Verbena hastata L.

Blue verbena. Rare. In area dominated by Phalaris arundinacea at south end of lake. 335.

Erect, roughly hairy, herbaceous perennial of moist fields, meadows, thickets, and swamps. Nova Scotia to British Columbia, south to California and northern Florida (Perry, 1933; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Lamiaceae

Lycopus americanus Muhl.

Water hore-hound. Occasional in zones near lake. 420.

Herbaceous perennial with elongate rhizomes, found in wet places. Newfoundland to southern British Columbia, south to California, New Mexico, Alabama, and Florida (Henderson, 1962; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Mentha arvensis L. var. glabrata (Benth.) Fern.

Wild mint. Common in higher, drier areas. 386, 436.

Herbaceous perennial of moist open soils. The only species of this genus indigenous to North America. Circumboreal distribution, in North America from southern Labrador and Nova Scotia to central Alaska, south to California, northeastern Nevada, northern New Mexico, northern Montana, eastern Kansas, Illinois, and Virginia (Scoggan, 1957; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977).

Monarda fistulosa L. var. fistulosa

Wild bergamot. Occasional in Potentilla-Carex zone of fen. 378.

Perennial herb of dry thickets, woods, and openings. This variety from southern Quebec and western New England, south to eastern Texas, the uplands of Georgia, Alabama, and North Carolina (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977). The range of the species as a whole extends westward to British Columbia and then south to Arizona (Gleason and Cronquist, 1963).

Prunella vulgaris L.

Self-heal. Rare. In drier open areas. 409.

Perennial herb of various disturbed and undisturbed sites. A circumpolar species. Naturalized in North America from Europe. Widely dispersed throughout North America and the rest of the Northern Hemisphere (Gleason and Cronquist, 1963; Fernald, 1970).

Pycnanthemum virginianum (L.) Durand & Jackson

Mountain mint. Common in higher, drier areas. 377.

Herbaceous perennial of upland woods, thickets, wet meadows and similar habitats. Maine to North Dakota, south to Oklahoma, upland area of eastern Tennessee, western North Carolina, and Georgia (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Scutellaria galericulata L.

Marsh skullcap. Occasional within areas dominated by Eleocharis rostellata and Scirpus acutus. 202, 333, 350, 369.

Herbaceous, rhizomatous perennial of wet soils. A circumboreal species. In North America from Newfoundland and southern Labrador, to James Bay and Alaska, south to California, New Mexico, Arkansas, and western North Carolina (Griggs, 1913; Gleason and Cronquist, 1963; Fernald, 1970; Hulten, 1971; Barkley, 1977).

Scrophulariaceae

Agalinis paupercula (Gray) Britt.

Gerardia. Scattered in Eleocharis rostellata and Scirpus acutus dominated areas. 342, 384, 405, 450.

Herbaceous annual of bogs, shores, and other wet open ground. Southwestern Gaspe Peninsula to Minnesota, Iowa, Indiana, and northern New Jersey (Pennell, 1935; Fernald, 1970).

Chelone glabra L.

Turtlehead. Rare. 433.

Highly variable herbaceous perennial of stream margins, wet thickets, and other low ground. Newfoundland to southeastern Manitoba, south to northeastern Iowa, northern Alabama and Georgia, and mountains of South Carolina (Pennell, 1935; Gleason and Cronquist, 1963; Fernald, 1970).

Mimulus ringens L.

Monkey-flower. Rare. In small area dominated by Carex stricta in south end of area along creek. 403, 415.

Herbaceous perennial from stoloniferous rhizomes in wet woods, swamps, and other wet places. Cape Breton Island and the Gaspe Peninsula to extreme southeastern Saskatchewan, south to north central Colorado, south central Oklahoma, Missouri, Alabama, and the highlands of Georgia and South Carolina (Pennell, 1935; Deam, 1940; Gleason and Cronquist, 1963; Steyermark, 1963; Radford et al., 1968; Seymour, 1969; Correll and Johnston, 1970; Fernald, 1970; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1979; Wherry, Fogg, and Wahl, 1979).

Pedicularis lanceolata Michx.

Lousewort. Occasional in herbaceous fen vegetation. 434.

Erect, herbaceous perennial in rich, wet, often calcareous soils. Massachusetts to southern Manitoba, south to Nebraska, extreme southeastern Missouri, Indiana, Ohio, and the mountains of North Carolina (Pennell, 1935; Gleason and Cronquist, 1963; Fernald, 1970).

Lentibulariaceae

Utricularia cornuta Michx.

Horned bladderwort. Rare. In small open mud flats within spring flows and in few areas along lake's edge. 256.

Terrestial herb with delicate underground stems and finely divided roots bearing minute bladders. Wet, peaty, sandy, or muddy shores. Newfoundland and Nova Scotia to Wisconsin, northern Illinois and Indiana, Ohio, and Pennsylvania, and on the Coastal Plain from New Jersey to Florida, Alabama, and eastern Texas (McLaughlin, 1932; Deam, 1940; Strausbaugh and Core, 1952; Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Kondo, 1972; Mohlenbrock and Ladd, 1978; Wherry, Fogg, and Wahl, 1979).

Campanulaceae

Campanula aparinoides Pursh

Marsh bellflower. Common in Potentilla-Carex zone and also found in Eleocharis-Scirpus zone of fen. 344.

Herbaceous perennial from filiform rhizomes in wet sunny meadows. Nova Scotia to Saskatchewan, south to Colorado, Arkansas, and Georgia (Gleason and Cronquist, 1963; Shetler, 1963; Steyermark, 1963; Fernald, 1970; Barkley, 1977; Godfrey and Wooten, 1981).

Lobelia kalmii L.

Kalm's lobelia. Common among Eleocharis rostellata and Scirpus acutus at lake's edge. 370.

Slender herbaceous perennial of calcareous shores and swamps. Newfoundland and Cape Breton Island to the southwestern Mackenzie

District and northern British Columbia, south to Washington, Montana, Colorado, Iowa, Illinois, Pennsylvania, and New Jersey (McVaugh, 1936; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Scoggan, 1979).

Lobelia siphilitica L. var. siphilitica

Great lobelia. Frequent in Potentilla-Carex fen zone. 431.

Stout herbaceous perennial from thick fibrous rootstock. Maine to Manitoba, south to Colorado, Texas, Arkansas, Mississippi, and mountains of North Carolina and Alabama (McVaugh, 1936; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Godfrey and Wooten, 1981).

Rubiaceae

Galium aparine L.

Cleavers. Occasional. Scattered in some herbaceous vegetation and shrub-carr areas near forest's edge. 265, 297.

Reclining annual herb with a short tap root. In rich woods, thickets, and usually in the shade. A circumboreal species. Galium aparine is widespread in North America with two major ranges. One region of distribution includes the eastern half of the United States and adjacent Canada. The other extends from southern California north through the Aleutian Islands. In its entirety the range extends from Newfoundland to the southern coast of Alaska, south to California and Florida. The species also reported from central and southern Africa, Laos, southern Australia, New Zealand, and western South America as scattered populations from Bolivia to Tierra del Fuego (Gleason and

Cronquist, 1963; Kearney and Peebles, 1969; Fernald, 1970; Hulten, 1971; Welsh, 1974; Barkley, 1977; Martin and Hutchins, 1980).

Galium asprellum Michx.

Rough bedstraw. Local. In areas near forest's edge. 234, 348, 366.

Herbaceous perennial with creeping rhizomes and branched scrambling stems. Wet woods and damp thickets. Newfoundland and Nova Scotia to Ontario and Minnesota, south to Nebraska, Missouri and North Carolina (Gleason and Cronquist, 1963; Fernald, 1970).

Galium boreale L.

Northern bedstraw. Common throughout Potentilla-Carex zone. 210, 237, 310.

Erect herbaceous perennial with creeping rhizomes. A circumboreal species. In North America from Nova Scotia to Alaska, south to southern California, Arizona, New Mexico, northern Nebraska, Iowa, Illinois, West Virginia, and New Jersey (Love and Love, 1954; Hulten, 1958; Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977).

Caprifoliaceae

Sambucus canadensis L.

Common elderberry. Occasional throughout drier areas. 298.

Shrub of moist rich soils. Cape Breton Island to Manitoba, south to Mexico and the West Indies (Gleason and Cronquist, 1963; Fernald, 1970; Barkley, 1977; Little, 1977).

Viburnum cassinoides L.

Wild raisin. Occasional, in thickets on higher elevations of the wetland. 388, 500.

Shrub to four meters in clearings, thickets, wet woods, and swamps. Newfoundland to southern Quebec and Ontario, south to Wisconsin, Alabama, and Florida (Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Scoggan, 1979; Godfrey and Wooten, 1981).

Valerianaceae

Valeriana sitchensis Bong. ssp. uliginosa (T&G) F.G. Meyer [Valeriana uliginosa (T&G) Rydberg]

Valerian. Occasional throughout the area. 208, 236.

Herbaceous perennial from stout rhizome or caudex with fibrous roots. Calcareous swamps, bogs, and meadows. New Brunswick to Quebec, south to the upper and lower peninsulas of Michigan, northern Ohio, New York, and Connecticut (Meyer, 1951; Gleason and Cronquist, 1963; Fernald, 1970).

Asteraceae

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper

Common yarrow. Scattered throughout study area. 299.

Aromatic perennial herb from rhizomes. Most commonly found in disturbed sites (Gleason and Cronquist, 1963). Circumboreal species ranging from Pennsylvania, Oklahoma, New Mexico, and California, north to Arctic Slope of Alaska and Canada (Mulligan and Bassett, 1959; Barkley, 1977). Species also found in Mexico, Patagonia, Australia, and New Zealand (Hulten, 1971).

Aster lucidulus (Gray) Wieg.

Red-stalk aster. Scattered throughout the study area. 459, 472.

Colonial, herbaceous perennial from long creeping rhizomes. Moist places. New York to Minnesota and South Dakota, south to Missouri and West Virginia (Gleason and Cronquist, 1963).

Aster novae-angliae L.

New England aster. Occasional throughout the study area. 430, 448, 458, 471.

Perennial herb from stout candex or rhizome in various damp, open, or wooded places (Gleason and Cronquist, 1963). Maine to Alberta, south to Colorado, Arkansas, and Georgia (Parker, 1932; Gleason and Cronquist, 1963; Fernald, 1970; Van Faasen, 1971). Also cultivated and escaped in many areas not listed (Fernald, 1970).

Aster simplex Willd. var. simplex

Panicled aster. Frequent throughout the study area. 424, 451, 460, 477.

Stout, perennial herb from creeping rhizome in various low moist habitats (Gleason and Cronquist, 1963; Fernald, 1970). Labrador, Nova Scotia, and New Brunswick to Virginia and mountains of North Carolina west to Texas and Saskatchewan (Gleason and Cronquist, 1963; Fernald, 1970; van Fassen, 1971; Barkley, 1977; Godfrey and Wooten, 1981).

Aster umbellatus Mill.

Flat-topped white aster. Occasional throughout study area. 419, 425, 457.

Coarsely rhizomatous, perennial herb of damp to dryish meadows and thickets (Fernald, 1970). New Brunswick and Nova Scotia to Minnesota, south to Texas, northwestern Arkansas, Kentucky, the mountains of North Carolina, and northern Georgia (Parker, 1936; Gleason and Cronquist, 1963; Fernald, 1970; Van Faasen, 1971). Godfrey and Wooten (1981) separate ours as var. umbellatus and treat a coastal plain element as var. latifolius Gray. Parker (1932) maps this species with a southwesterly distribution, but this is not supported by the previously cited literature.

Bidens cernua L.

Stick-tight. Occasional in very wet areas such as along edge of lake and creeks. 449.

Herbaceous annual of low wet places. An amphi-Atlantic species also present in the Old World, although absent from the Southern Hemisphere. In North America from Cape Breton Island and New Brunswick to Great Slave Lake (Mackenzie District) and southern British Columbia, south to northern California, northern New Mexico, southern Ohio, and the mountains of North Carolina and Georgia (Rydberg, 1906; Sherff, 1937; Deam, 1940; Hulten, 1958; Gleason and Cronquist, 1963; Radford et al., 1968; Fernald, 1970; Munz, 1973; Barkley, 1977; Mohlenbrock and Ladd, 1978; Scoggan, 1979; Martin and Hutchins, 1980; Godfrey and Wooten, 1981).

Cirsium muticum Michx. var. muticum

Swamp thistle. Occasional in elevated drier areas of the fen. 426.

Biennial herb with turnip-shaped roots of low woods, swamps, and other moist soils. Labrador to Saskatchewan, south to Texas and Florida (Frankton and Moore, 1963; Gleason and Cronquist, 1963; Fernald, 1970).

Erigeron philadelphicus L.

Fleabane. Occasional throughout the study area. 205, 305.

A somewhat weedy biennial or short-lived perennial herb of rich thickets, alluvium, springy slopes, and various other habitats (Gleason and Cronquist, 1963; Fernald, 1970). Throughout most of United States and Canada even to Arctic Circle, but less common over most of Rocky Mountain region (Cronquist, 1947; Scoggan, 1957, 1979).

Eupatorium maculatum L. var. maculatum

Joe-Pye weed. Common throughout open areas. 429.

A coarse perennial herb of moist and especially calcareous places. Newfoundland to British Columbia, south to New Mexico, Illinois, Ohio, and the mountains of Virginia and North Carolina (Gleason and Cronquist, 1963; Fernald, 1970).

Eupatorium perfoliatum L. var. perfoliatum

Boneset. Common near lake. 428.

Stoutly rhizomatous, coarse, perennial herb of low woods, prairies, and various other wet places (Frankton and Moore, 1963; Gleason and Cronquist, 1963; Fernald, 1970). Quebec to southeastern Manitoba, south to Minnesota, Nebraska, Texas, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; King and Robinson, 1970).

Helianthus giganteus L.

Giant sunflower. Occasional in Potentilla-Carex zone of the fen along northwest side of lake. 365, 385, 442, 452.

Herbaceous, perennial with rhizomes and often fleshy roots. Swamps and other moist places. Gaspe Peninsula to Alberta, south to Colorado and Florida (Watson, 1928; Long, 1961; Gleason and Cronquist, 1963; Heiser, 1969; Fernald, 1970).

Hieracium caespitosum Dumort

King devil. Rare, on sandy soil of abandoned roadbed at outlet of lake. 497.

An herbaceous, perennial from a short to, less often, elongate rhizome in pastures, clearings, and roadsides. An introduced species in North America from Nova Scotia and the Gaspe Peninsula, to Ontario, south to Tennessee and northern Georgia (Gleason and Cronquist, 1963; Fernald, 1970).

These specimens key out as Hieracium pratense Tausch in Gleason and Cronquist (1963). Voss and Bohlke (1978) include H. pratense in the broad concept of H. piloselloides, but allow that H. pratense may be segregated on the basis of the densely hairy nature of the leaves and stems and the large size of the heads. Hieracium pratense was published in 1828 (Britton and Brown, 1913), however, H. caespitosum has priority because it was published in 1827 (Tutin, 1976).

Leucanthemum vulgare Lam. [Chrysanthemum leucanthemum L.]

Ox-eye daisy. Frequent in higher, drier areas. 207.

Herbaceous perennial with rhizomes in fields and waste places (Gleason and Cronquist, 1963). A circumpolar species native to Eurasia, now naturalized throughout most of North America (Gleason and Cronquist, 1963; Fernald, 1970).

Liatris spicata (L.) Willd.

Blazing star. Rare in small area along southwest shore of lake. 392.

Erect, rhizomatous, herbaceous perennial of wet meadows, borders of marshes, and other damp places. Herb of moist and especially calcareous places. New York to southern Ontario and Wisconsin, south to Louisiana, and Florida (Gleason and Cronquist, 1963; Fernald, 1970; Scoggan, 1979).

Rudbeckia hirta L.

Black-eyed susan. Common throughout the study area. 345.

Biennial or short-lived perennial herb of thickets, open woods, fields, and various other habitats. Newfoundland to British Columbia, south to Mexico and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Rudbeckia laciniata L. var. laciniata

Green-headed coneflower. Rare. One small group of individuals in south end of study area. 414.

Coarse perennial herb of low moist places. Nova Scotia, southern Quebec to Montana, south to Arizona, Louisiana, and Florida (Gleason and Cronquist, 1963; Fernald, 1970).

Senecio aureus L.

Golden ragwort. Occasional throughout all but the wettest open herbaceous vegetation. 499.

Herbaceous perennial herb from a creeping rhizome or a branched, rhizomatous caudex. Rich calcareous woods, bottom lands, and swampy places. Labrador to Minnesota, south to Arkansas and Florida (Barkley, 1962; Gleason and Cronquist, 1963; Fernald, 1970).

Solidago canadensis L. var. canadensis

Canadian goldenrod. Common to even dominant in some areas. 412, 455.

Herbaceous perennial with rhizomes. Moist to dry soils of various habitats. The species is found throughout the United States and Canada to Alaska. This variety is known from Newfoundland to Manitoba, south to Colorado, Illinois, and Virginia (Ramaley, 1939; Gleason and Cronquist, 1963; Fernald, 1970).

Solidago graminifolia (L.) Salisb. var. graminifolia

Grass-leaved goldenrod. Occasional throughout the region. 470, 475.

Rhizomatous, herbaceous perennial of moist ground and open habitats. Newfoundland to British Columbia and southwestern Mackenzie District, south to New Mexico, Iowa, Illinois, and Virginia; reportedly found south to Florida and Alabama (Scoggan, 1957, 1979; Gleason and Cronquist, 1963; Fernald, 1970).

Solidago ohioensis Riddell

Ohio goldenrod. Frequent throughout. 422.

Perennial herb of swamps, beaches, wet prairies, fens, and other wet places (Gleason and Cronquist, 1963; Fernald, 1970; Pringle, 1982). New York to Michigan's upper peninsula, south to Ohio, Indiana, and Illinois (Pringle, 1982).

Solidago patula Muhl.

Rough-leaved goldenrod. Common in fen area. 421.

Perennial herb from a short caudex. Most often in calcareous or clayey places, but also in other wet areas. Maine to Minnesota, south to Texas, Alabama, and Georgia (Friesner, 1933; Gleason and Cronquist, 1963; Fernald, 1970; Godfrey and Wooten, 1981).

Solidago riddellii Frank.

Riddell's goldenrod. Rare. Scattered within herbaceous vegetation of southern third of area. 456.

Stout, rhizomatous perennial herb to one meter. Swamps, wet prairies, and other moist open habitats. Eastern Ontario to Minnesota, south to Missouri and Ohio; also reported in one location in Virginia (Gleason and Cronquist, 1963; Fernald, 1970).

Solidago rugosa Mill. ssp. rugosa var. rugosa

Rough-stemmed goldenrod. Frequent throughout. 443, 465.

Rhizomatous, perennial herb of various damp habitats. Newfoundland to Manitoba, south to Texas, Louisiana, and Florida (Friesner, 1933; Gleason and Cronquist, 1963; Fernald, 1970).

Solidago uliginosa Nutt. var. uliginosa

Bog goldenrod. Occasional in wetter areas of fen at lake's edge. 423.

Herbaceous perennial of acid swamps, moist to dry thickets, and meadows. Newfoundland and Quebec to Minnesota, south to Indiana and the mountains of North Carolina (Friesner, 1933; Gleason and Cronquist, 1963; Fernald, 1970).

Taraxacum officinale Weber

Common dandelion. Rare in open fen vegetation northeast of lake. Stoynoff (pers. observ.).

Herbaceous perennial from a taproot. Common in lawns and disturbed sites. An introduced species from Eurasia, now a temperate region cosmopolitan weed (Gleason and Cronquist, 1963).

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