TABLE 4. Origin, date and location of first sighting, and entry mechanism(s) for non-indigenous aquatic plants and algae of the Great Lakes. For location and introduction mechanism codes see Tables 1 and 2.

Tax on	Species	Common Name	Origin	Date	Location	Mechanism
Algae						
Chlorophyceae	*Enteromorpha intestinalis*	green alga	Atlantic	1926	Wolf Creek (O)	R(A)
	Enteromorpha prolifera	green alga	Atlantic	1979	Lake St. Clair	Unknown
	Nitellopsis obtusa	green alga	Eurasia	1983	Lake St. Clair	S(BW)
Chrysophyceae	*Hymenomonas roseola*	coccolithophorid	Eurasia	1975	Lake Huron	S(BW)
Bacillariophyceae	*Actinocyclus normanii fo. subsalsa*	diatom	Eurasia	1938	Lake Ontario	S(BW)
	Biddulphia laevis	diatom	widespread	1978	Lake Michigan	S(BW)
	Cyclotella atomus	diatom	widespread	1964	Lake Michigan	S(BW)
	Chaetoceros hohnii	diatom	unknown	1978	Lake Huron	S(BW)
	Skeletonema potamos	diatom	widespread	1963	Toledo, Ohio (E)	S(BW)
	Skeletonema subsalsum	diatom	Eurasia	1973	Sandusky Bay (E)	S(BW)
	Stephanadiscus binderanus	diatom	Eurasia	1938	Lake Michigan	S(BW)
	Stephanodiscus subtilis	diatom	Eurasia	1946	Lake Michigan	S(BW)
	Thalassiosira guillardii	diatom	widespread	1973	Sandusky Bay (E)	S(BW)
	Thalassiosira lacustris	diatom	widespread	<1978	Lake Erie	S(BW)
	Thalassiosira pseudonana	diatom	widespread	1973	Ohio (E)	S(BW)
	Thalassiosira weissflogii	diatom	widespread	1962	Detroit River	S(BW)
	Diatoma ehrenbergii	diatom	widespread	1930s	Lake Michigan	S(BW)
	Cyclotella cryptica	diatom	widespread	1964	Lake Michigan	S(BW)
	Cyclotella pseudostelligera	diatom	widespread	1946	Lake Michigan	S(BW)
	Cyclotella woltereki	diatom	widespread	1964	Lake Michigan	S(BW)
Phaeophyceae	*Sphacelaria fluviatilis*	brown alga	Asia	1975	Gull Lake (M)	R(AQ), R(A)
	Sphacelaria lacustris	brown alga	unknown	1975	Lake Michigan	S(BW)
Rhodophyceae	*Bangia atropurpurea*	red alga	widespread	1964	Lake Erie	S(BW), S(F)
	Chroodactylon ramosum	red alga	Atlantic	1964	Lake Erie	S(BW)
Submerged Plants						
Marsileaceae	*Marsilea quadrifolia*	European water clover	Eurasia	<1925	Cayuga Lake (O)	R(D)
Cabombaceae	*Cabomba caroliniana*	fanwort	Southern U.S.	1935	Kimble Lake (M)	R(AQ), R(A)
Brassicaceae	*Rorippa nasturtium aquaticum*	water cress	Eurasia	1847	Niagara Falls (O)	R(C)
Haloragaceae	*Myriophyllum spicatum*	Eurasian watermilfoil	Eurasia	1952	Lake Erie	R(AQ), S(F)
Trapaceae	*Trapa natans*	water chestnut	Eurasia	<1959	Lake Ontario (T)	R(A), R(AQ)
Menyanthaceae	*Nymphoides peltata*	yellow floating heart	Eurasia	1930	Conneaut River (E)	R(A)
Hydrocharitaceae	*Hydrocharis morsus-ranae*	European frog-bit	Eurasia	1972	Lake Ontario	R(AQ),R(D,S(F)
Potamogetonaceae	*Potamogeton crispus*	curly pondweed	Eurasia	1879	Keuka Lake (O)	R(D), R(F)
Najadaceae	*Najas marina*	spiny naiad	Eurasia	1864	Onondaga Lake (O)	S(SB)
	Najas minor	minor naiad	Eurasia	1932	Lake Cardinal (E)	R(D)
Marsh Plants						
Chenopodiaceae	*Chenopodium glaucum*	oak leaved goose foot	Eurasia	1867	Onondaga Lake (O)	RH
Caryophylliaceae	*Stellaria aquatica*	giant chickweed	Eurasia	1894	Lake St. Clair	unknown
Polygonaceae	*Polygonum caespitosum var. longisetum*	bristly lady's thumb	Asia	1960	Ohio (E)	unknown
	Polygonum persicaria	lady's thumb	Eurasia	<1843	widespread	unknown
	Rumex longifolius	yard dock	Eurasia	1901	isle Royale (S)	R(C)
	Rumex obtusifolius	bitter dock	Eurasia	<1840	widespread	unknown

Continued

TABLE 4. Continued

Taxon	Species	Common Name	Origin	Date	Location	Mechanism
Brassicaceae	*Rorippa sylvestris*	creeping yellow cress	Eurasia	1884	Rochester, NY (O)	S(SB)
Primulaceae	*Lysimachia nummularia*	moneywort	Eurasia	1882	central NY (O)	R(C)
	Lysimachia vulgaris	garden loosestrife	Eurasia	1913	central NY (O)	R(C)
Lythraceae	*Lyhrum salicaria*	purple loosestrife	Eurasia	1869	Ithaca, NY (O)	C, S(SB)
Onagraceae	*Epilobium hirsutum*	great hairy willow herb	Eurasia	1874	Ithaca, NY (O)	R(A), S(SB)
	Epilobium parviflorum	small flowered hairy willow herb	Eurasia	1966	Benzie Co., MI (M)	unknown
Apiaceae	*Conium macalatum*	poison hemlock	Eurasia	<1843	widespread	R(C)
Solanaceae	*Solarium dulcamara*	bittersweet nightshade	Eurasia	<1843	widespread	R(C)
Boraginaceae	*Myosotis scorpioides*	true forget-me-not	Eurasia	1886	central NY (O)	R(C)
Lamiaceae	*Lycopus asper*	western water horehound	Mississippi	1892	Lake Erie	R(A)
	Lycopus europaeus	European water horehound	Eurasia	1903	Lake Ontario	S(SB)
	Mentha gentilis	creeping whorled mint	Eurasia	1915	central NY (O)	R(C)
	Mentha piperita	peppermint	Eurasia	<1843	widespread	R(C)
	Mentha spicata	spearmint	Eurasia	<1843	widespread	R(C)
Scrophulariaceae	*Veronica beccabunga*	European brookline	Eurasia	1915	Monroe Co., NY (O)	S(SB)
Asteraceae	*Cirsium palustre*	marsh thistle	Eurasia	<1950	Lake Superior	unknown
	Pluchea odorata var. *succulents*	salt-marsh fleabane	Atlantic	<1950	central NY (O)	unknown
	var. purpurescens	salt-marsh fleabane	Atlantic	1916	Lake Erie (T)	R(A)
	Solidago sempervirens	seaside goldenrod	Atlantic	1969	Chicago (M)	R(A)
	Sonchus arvensis	field sow thistle	Eurasia	1865	central NY	R(A)
	Sonchus arvensis var. *glabrescent*	smooth field sow thistle	Eurasia	1902	Ohio (E)	R(A)
Butomaceae	*Butomus umbellatus*	flowering rush	Eurasia	<1930	Detroit River (E)	S(SB)
Balsaminaceae	*Impatiens glandulifera*	Indian balsam	Asia	1912	Port Huron (H)	R(C)
Juncaceae	*Juncus compresses*	flattened rush	Eurasia	<1895	Cayuga Lake (O)	R(A)
	Juncus gerardii	black-grass rush	Atlantic	1862	Chicago	S(SB)
	Juncus inflexus	rush	Eurasia	1922	central, NY	unknown
Cyperaceae	*Carex acutiformis*	swamp sedge	Eurasia	1951	St. Joseph Lake (M)	unknown
	Carex disticha	sedge	Eurasia	1866	Belleville, Ontario (O)	S(SB)
	Carex flacca	sedge	Eurasia	1896	Detroit River	unknown
Poaceae	*Agrostis gigantea*	redtop	Eurasia	1884	Ontario (S)	R(C)
	Alopecurus geniculatus	water foxtail	Eurasia	1882	Lake Erie	R(C)
	Echinochloa crusgalli	barnyard grass	Eurasia	<1843	widespread	R(C), S(SB)
	Glyceria maxima	reed sweet-grass	Eurasia	1940	Lake Ontario	R(C), S(SB)
	Poa trivalis	rough-stalked meadow grass	Eurasia	<1843	widespread	R(C), S(SB)
	Puccinellia distans	weeping alkali grass	Eurasia	1893	Montezuma, NY (O)	S(SB). RH
Sparganiaceae	*Sparganium glomeratum*	bur reed	Eurasia	1936	Lake Superior	unknown
Typhaceae	*Typha angustifolia*	narrow leaved cattail	Eurasia	1880s	central NY (O)	C, R(A)
Iridaceae	*Iris pseudacorus*	yellow flag	Eurasia	1886	Ithaca, NY (O)	R(C)
Shoreline Trees and Shrubs						
Betulaceae	*Alnus glutinosa*	black alder	Eurasia	<1913	widespread	R(C)
Salicaceae	*Salix alba*	white willow	Eurasia	<1886	widespread	R(C)
	Salix fragilis	crack willow	Eurasia	<1886	widespread	R(C)
	Salix purpurea	purple willow	Eurasia	<1886	widespread	R(C)
Rhamnaceae	*Rhamnus frangula*	glossy buckthorn	Eurasia	<1913	Ontario	R(C)

the Atlantic Coast in the Great Lakes drainage from Wolf Creek near Silver Springs, New York, in 1926. Taft (1964b) reported collections of *Enteromorpha inrestinalis* from the Portage River west of Elmore, Ohio, in 1951 on a fault in the limestone bedrock where water was upwelling. Catling and McKay (1980) reported the first records of *Enteromorpha intestinalis* in Ontario in saline habitat near the Ojibway Salt Mine near the Detroit River in 1979. They noted that their findings were the first records of this algal species in Ontario. Neither of the forms are noted inland by Collins (1928).

Enteromorpha prolifera GREEN ALGA

Catling and McKay (1980) found this green alga in a pool near a salt factory in Windsor, Ontario, in 1979 in the Lake St. Chair drainage. They noted that this record was the first known of the alga in Ontario. This algal species, although primarily marine, was reported from inland salt springs by Collins (1928). The mechanism through which this species was introduced remains unknown.

Nitellopsis obtusa GREEN ALGA

First records of this Eurasian green alga in North America were in 1978 when the plant was found in the St. Lawrence River (Geis *et al 1981).* At the time of this study, the plant was found to be present in many sites along the St. Lawrence River from east of Clayton, New York, to east of Ogdensburg, New York (Geis *et al.* 1981). More recent studies document the alga in the St. Clair-Detroit River system in 1983 (Schloesser *et al.* 1986). Ranked as the ninth-most frequently collected macrophyte in the St. Clair-Detroit River system, *Nitellopsis* was more frequently observed there than *Potamogeton crispus,* another common Great Lakes exotic. This alga is considered a ballast water introduction.

Chrysophyceae:

Hymenomonas roseola COCCOLITHOPHORID

Stoermer and Sicko-Goad (1977) first collected this coccolithophorid in the Great Lakes in Saginaw Bay, Lake Huron, in 1975. It normally inhabits eutrophic areas, ponds, and small lakes, polluted rivers, and "slightly brackish upper reaches of coastal estuaries" in Europe (Stoermer and Sicko-Goad 1977). In Ohio, *Hymenomonus roseola* was rare in the Scotio River which is in the Mississippi River basin in 1937-1938 (Lackey 1939). *Hymenomonas roseola* could have been introduced in the ballast water of ocean going ships from Europe or transferred from Ohio to Lake Huron through another mechanism.

Bacillariophyceae:

Actinocyclus normanii fo. subsalsa DIATOM

This diatom is common in coastal waters of Germany and Norway, the Baltic and Caspian Seas, and freshwaters of Northern Germany (Hasle 1977, 1978). Studies of the sediments of Lake Ontario have determined that *Actinocyclus normanii* fo. *subsalsa* arrived around 1938 (Stoermer *et al.* 1985). The species is known from the plankton of Lakes Michigan, Erie, Ontario, and Huron (Stoermer and Yang 1969, Stoermer and Theriot 1983, Stoemner *et al.* 1985).

Biddulphia laevis DIATOM

This diatom, known from lakes and streams in the south and midwest (Weber 1971) and from North Sea estuaries and the west coast of Africa (Sheath 1987), was not known in the Great Lakes until 1978 when it was observed at the Wyoming water treatment plant on the southern basin of Lake Michigan (Wujek and Welling 1981). This diatom comprised 1% of the total phytoplankton population in an area of Lake Michigan which has higher concentrations of chloride ions than other sites in the lake (Wujek and Welling 1981). Wujek and Welling (1981) noted the halophyllic nature of this diatom and implicated an increase in chloride concentrations in the establishment of this species in the Great Lakes. This diatom is likely a ballast water invader as species of *Biddulphia* were identified in the ballast of foreign ships entering the Great Lakes in the early 1980s (Bio-Environmental Services Ltd. 1981).

Cyciotella atomus DIATOM

Cyclotella atomus is found in European coastal waters of varied salinity, Java, and South Africa (Belcher and Swale 1978, Nicholls 1981). In Lakes Michigan, Ontario, Huron, and Erie, this diatom has become common (Stoermer and Yang 1969, Sreenivasa and Nalewajko 1975, Stoermer 1978, Nicholls and Carney 1979, Stoermer and Theriot 1983) in localities of "high loadings of dissolved solids" (Sheath 1987). It was collected in 1964 in Lake Michigan (Stoermer and Yang 1969) and was discovered in the sediments of Lake Ontario before it was found in the plankton (Duthie and Sreenivasa 1972). *Cyciotella atomus* is also widespread in North American rivers (Hohn and Hellerman 1963, Weber 1971, Lowe and Busch 1975), thus, the ori-

gin ot the Great Lakes populations cannot be determined.

Chaetoceros hohnii DIATOM

Chaetoceros honhii was first described as a new species in Saginaw Bay, Lake Huron, in 1978 (Wujek and Graebner 1980). Because the populations were found in areas of high ion content (Wujek and Graebner 1980) and since *Chaetoceros is* generally a marine genus, the species is thought to have originated in a marine or brackish environment (Sheath 1987). The transcontinental introduction of a previously undescribed species in ballast water is a probable explanation for the presence of this diatom in Great Lakes waters. Many non-indigenous species are known to have been first described in the region into where they have been introduced, rather than their native localities (Carlton 1979). Species of *Chaetoceros* non-indigenous to the Great Lakes have been found in surveys of ballast water entering the Great Lakes (Bio-Environmental Services Ltd. 1981).

Skeietonema potamos DIATOM

Skeletonema potamos, first described by Weber (1970) from the Little Miami River at Cincinnati, is a diatom with a wide salinity tolerance. It is known from German waters and from North American rivers (Hasle and Evensen 1976). In North America, the diatom is widespread, common in the Atlantic, Pacific, and Mississippi drainages and was present in the Great Lakes basin at Toledo, Ohio, by 1963 (Weber 1970). In the Great Lakes, the diatom has been found in Sandusky Bay, Lake Erie (Hasle and Evensen 1976), the north shore of Lake Erie (Nicholls *et aI.* 1983), Lake Ontario (Stoermer 1978, Nicholls and Carney 1979), and Saginaw Bay, Lake Huron (Stoermer and Theriot 1983). This diatom could have either been introduced with ballast water from the North American rivers listed above. from the German waters where it has been a common component of the phytoplankton since 1922, or from rivers in England and France (Hasle and Evensen 1976, Belcher and Swale 1978).

Skeletonema subsalsurn DIATOM

The earliest report of this brackish diatom, known from the Baltic Sea, the Caspian Sea, and Northern Germany, was in North America in Sandusky Bay, Lake Erie, in 1973 (Hasle and Evensen 1975). Stoermer (1978) noted its occurrence in Lake Erie, Lake Ontario, and nearshore areas of Lake Michigan and southern Lake Huron.

Stephanodiscus binderanus DIATOM

The earliest records of this Eurasian diatom from. North America are from Lake Michigan in 1938 (Stoermer and Yang 1969). Originally described from the Baltic (Stoermer *et al.* 1979), it is known from the sediments of Lake Ontario and is estimated to have first occurred there in 1952 (Stoermer *et al.* 1985). Although the diatom was present in the Great Lakes-St. Lawrence River system since as early as 1938, it was not discovered until 1955 in the St. Lawrence River at Montreal (Brunei 1956). After its introduction into the Great Lakes basin, *Stephanodiscus binderanus* became established in the St. Lawrence River (Brunei 1956), Lake Ontario (Nalewajko 1966, Nicholls and Carney 1979), Lake Erie (Wujek 1967, Nicholls ***et al.*** 1983), Lake Michigan (Stoermer and Yang 1969), and Saginaw Bay, Lake Huron (Stoermer and Theriot 1983). Dominant populations of this species are known to cause water quality problems in municipal water treatment facilities (Brunei 1956, Vaughn 1961, Stoermer and Yang 1969).

Stephanodiscus subtilis DIATOM

This diatom was not discovered in Lake Michigan until 1946. In the 1960s it was common in eutrophic areas and habitats contaminated with chloride (Stoermer and Yang 1969). In 1972, the species was found in Lake Ontario where it had reached high densities (Stoermer *et al.* 1975). The diatom is also a component of the Lake Erie (Stoermer 1978) and Saginaw Bay, Lake Huron, phytoplankton (Stoerrner and Theriot 1983). *Stephanodiscus subtilis* is also known from the North Sea, rivers in Holland, and in Sweden (Nicholls 1981).

Thalassiosira guillardii DIATOM

The earliest records of ***Thalassiosira guillardii*** in North America are from Sandusky Bay, Lake Erie, in 1973 (Hasle 1978). It is common in coastal waters of the Pacific and Atlantic, the Baltic Sea, the River Weser in Germany, and the River Thames in Great Britain (Hasle 1978). Early Great Lake diatom collections either do not contain this diatom, or contain inconclusive fragments (Hasle 1978).

Thalassiosira lacustris DIATOM

Hasle (1978) noted *Thafassiosira lacustris* from Pacific and Atlantic coastal waters, the Baltic Sea, the Caspian Sea, the River Weser in Germany, Lake Erie, and U.S. inland waters.

Thalassiosira pseudonana DIATOM

The earliest reported collections in the Great Lakes of *Thalassiosira pseudonana* are from 1973 from Miller Blue Hole, Ohio, an artesian well in the Lake Erie drainage (Lowe and Busch 1975). Stoermer (1978) reported the diatom from nearshore areas of Lake Michigan and bays of Lakes Ontario and Erie. The only other North American records of the diatom, also known from Europe (Belcher and Swale 1977), are from coastal waters near Long Island, New York, and from a brackish pond on Long Island (Lowe and Busch 1975). Although the locality where this diatom was first found in the Great Lakes (e.g., an artesian well) is obscure, it is most likely a ballast introduction. This diatom could have been introduced secondarily from Lake Erie into the artesian well and reflects the potential time lag between the actual introduction of an algal species and its discovery. For example, *Stephanodiscus bideranus* was not reported from North America until 1955 but it was present in Lake Michigan phytoplankton collections from 1938 (Brunel 1956, Stoermer and Yang 1969).

Thalassiosira weissflogii
(= Thaiassiosira fluviatilis) DIATOM

Hasle (1978) noted the synonymy of *Thalassiosira fluviatilis* Hust and *Thalassiosira weissflogii* G. Fryx. & Hasle. The earliest reports of *Thalassiosira fluviatilis* are from the Detroit River in 1962-1963 (Wujek 1967), from Lake Michigan in 1967 (Stoermer and Yang 1969), and the Portage River, Ohio, in 1973 (Lowe and Busch 1975). Stoermer (1978) reported the diatom common from nearshore areas of Lake Michigan and bays of Lakes Erie and Ontario. The diatom is also known from the Potomac River, from Midwestern rivers and streams (Lowe and Busch 1975), and is common in estuaries in Europe and in Asia (Belcher and Swale 1977). It thrives at salinities ranging from 5% to full-strength seawater (Belcher and Swale 1977).

The four diatom species listed below are species that were not discovered in the lakes until the mid-twentieth century. The published information on these diatoms is scant and their source or origin unknown. All are widespread species.

Diatoma ehrenbergii DIATOM

Diatoma ehrenbergii is found in eutrophic areas of Lake Michigan and was not discovered in Lake Michigan until the late 1930s (Stoermer and Yang 1969). Stoermer and Theriot (1983) report the species from Saginaw Bay, Lake Huron, in low abundance.

Cyclotella cryptica DIATOM

This diatom was first discovered in Lake Michigan in 1964 (Stoermer and Yang 1969). In the 1960s, it was a rare part of the flora of harbors and inshore areas with high chloride concentrations (Stoermer and Yang 1969). It is now known from Lake Michigan, Ontario, Huron, and Erie (Stoermer 1978, Stoerrner and Theriot 1983).

Cyclotella pseudostelligera DIATOM

This diatom was first discovered in Lake Michigan in 1946 and has become abundant in eutrophic waters close to shore and estuaries in the lake (Stoermer and Yang 1969). Stoermer (1978) reported it from Lakes Michigan, Ontario, and Erie, and Nicholls and Carney (1979) reported it from the Bay of Quinte, Lake Ontario. More recently, the diatom was found in Saginaw Bay, Lake Huron (Stoermer and Theriot 1983).

Cyclotella woltereki DIATOM

This diatom species was first discovered in Lake Michigan in 1964 and was originally described from the tropics (Stoermer and Yang 1969).

Phaeophyceae:

Sphacelaria fluviatilis BROWN ALGA

Sphacelaria, a genus of brown algae generally considered marine, was first observed in 1975 in the Great Lakes watershed when *Sphacelaria fluviatilis* was found in Gull Lake, Michigan, which drains into Lake Michigan (Thompson 1975, Timpano 1978). It was previously known from western China (Jao 1943). *Sphacelaria fluviatilis* was most likely introduced through aquarium or another type of accidental release.

Sphacelaria lacustris BROWN ALGA

Soon after the discovery of *Sphacelaria fluviatilis* in 1975, the brown alga *Sphacelaria lacustris* was first described in Lake Michigan (Schloesser and Blum 1980). As in the case of *Chaetoceros honii, Sphacelaria lacustris* could be a previously undescribed ballast or aquarium introduction.

Sheath (1987) noted, as in the case of other marine algal invaders, the freshwater populations of the two species of brown algae discussed above are not known to undergo sexual reproduction, indicating that the populations evolved dependent upon

the marine environment. The unexpected occurrences of these algal species in Lake Michigan waters and their lack of sexual reproduction prompted Sheath (1987) to consider the genus *Sphacelaria* non-indigenous to the Great Lakes basin.

Rhodophyceae:

Bangia atropurpurea RED ALGA

This filamentous red alga native to the Atlantic Coast was observed in Buffalo Harbor in Lake Erie in 1964 (Lin and Blum 1977). After this sighting, records for the western basin of Lake Erie (Kishler and Taft 1970), Lake Ontario (Damann 1979), Lake Michigan (Lin and Blum 1977, Weik 1977), Lake Simcoe, Ontario (Jackson 1985), and Lake Huron (Sheath 1987) were reported. It has become a major species of the littoral flora of these lakes, generally occupying the littoral zone with *Cladophora* and *Ulothrix* (Blum 1982). Earliest records of this algae in the basin, however, go back to the 1940s when Smith and Moyle (1944) found the alga in Lake Superior tributaries. Matthews (1932) found the alga in another inland location at Quaker Run in the Allegheny drainage basin. The early records of this alga in Lake Superior tributaries could have been either unestablished introductions or misidentifications (Smith and Moyle 1944). The alga was not known in Lake Superior as of 1987. The prevailing belief is that this alga was transferred to the lower Great Lakes through ship fouling or ballast water.

Chroodactylon ramosum RED ALGA

This red alga, native to the Atlantic Ocean, was first reported in 1964 in the Great Lakes from western Lake Erie (Taft 1964a). An epiphyte on *Cladophora,* it is found in the Great Lakes from Lake Ontario to Lake Huron (Sheath and Morison 1982). The St. Lawrence River does not have the wave action to support the growth of *Chroodactylon ramosum* (Sheath and Morison 1982), so its natural migration up the river from the Atlantic is unlikely. The alga probably arrived in the ballast water of ships.

Plants

Botanists have observed the presence of non-indigenous plant species in the Great Lakes since the 1840s. Although many later invasions have been well documented through the examination of herbarium specimens (Stuckey 1966, 1980), invasions occurring early in the settlement of the Great Lakes region, like bittersweet nightshade, were not documented and the details of their introduction remain unknown. Many of the plants introduced into the Great Lakes have historically had medicinal or practical uses and were released from cultivation (Usher 1974). Plant taxonomy presented in Table 4 follows Gleason and Cronquist (1991).

Submersed Plants

Marsileaceae:

Marsilea quadrifolia EUROPEAN WATER CLOVER

European water clover, a plant native to Europe and Asia, was first found in North America at Bantam Lake in Litchfield, Connecticut (Gray 1867, Britton and Brown 1913). From this population, the plant was transferred into other parts of the eastern United States (Britton and Brown 1913). *Marsilea quadrifolia* will spread rapidly once it is established (Fernald 1950, Hotchkiss 1972). In the Great Lakes basin, Wiegand and Eames (1925) reported the plant from the Cayuga Lake basin and noted that it was introduced by early botanists of the region. The earliest flora of the Cayuga Lake basin was published by Dudley (1886), so introduction of the plant probably occurred before 1900. Dudley's (1886) *Cayuga Flora* did not, unfortunately, treat the Polypodiophyta, *Marsilea's* taxonomic group. Another population of *Marsilea quadrifolia* in the Great Lakes basin occurs in Nanticoke, Ontario, where it was well established in 1951. Nanticoke is near the north shore of Lake Erie east of Port Dover, Ontario. In the Great Lakes basin, the plant was also released near the Niagara River, above the falls, and to a pond near Lewiston, New York, but did not become established in these localities (Zenkert 1934).

Cabombaceae:

Cabomba caroliniana FANWORT

Cabomba caroliniana is a common aquarium and ornamental pond species that has been brought into the northeastern and midwestem United States and Canada from the southeastern United States (Voss 1985). In the Great Lakes basin, fanwort was first discovered in the St. Joseph River system during 1935 in Kimble Lake, Kalamazoo County, Michigan (Hanes 1938). The plant was soon found to be well established in other areas of this tributary (Voss 1985). In Ohio, the plant was first discovered in 1933 in Mosquito Creek, an Ohio River tributary (Rood 1947). The location of this collection, how-

ever, was not in the Great Lakes drainage basin. Montgomery (1948) reported the plant from Wellington, Ontario. Fanwort has also been released into Kansas (Magrath 1971), New Hampshire (Hodgdon 1959), and Massachusetts (Manning 1937, Gates 1958, Harris 1958).

Brassicaceae:

Rorippa nasturtium aquaticum WATER CRESS

The importation of water cress and its escape from cultivation was so widespread in the early-to-mid 1800s that its naturalization was not well documented. Established populations, most likely rising from plants cultivated for culinary purposes, were first observed in North America near Niagara Falls, Canada, in 1847 (Gray 1848). At this time, however, water cress was probably established in many areas of the Great Lakes watershed. Voss (1985) cited records from Ann Arbor, Michigan, from 1857. Since these early records, water cress has become established throughout North America (Green 1962).

Haloragaceae:

Myriophyllum spicatum EURASIAN WATERMILFOIL

Although this submersed aquatic plant is thought to have arrived much earlier, the first validated occurrence of Eurasian watermilfoil, a common aquarium species, in North America is from the Potomac River, Virginia, in 1881 (Reed 1977). The plant, although present in North America from the 1880s onward, did not cause any problems until the late 1950s when, due to increased concentrations of calcium in Chesapeake Bay, the populations grew to problematic proportions. For years, taxonomy of the North American watermilfoil was under debate, and, in most cases, all species of *Myriophyllum* were referred to as *Myriophyllum exalbescens*. Reed (1977) reviewed the taxonomic difficulties and documented the arrival and spread of the plant in the United States in more detail. In the Great Lakes basin, the first record occurred in 1882 in Paddy's Lake near Oswego, New York. No specimens, however, were collected again until 1960 when the plant was found at Sodus Bay, Lake Ontario, and in Rochester, New York. The first observations of established populations of the plant in the Great Lakes basin were in 1952 at Put-in-Bay in western Lake Erie (Stuckey 1988). Many new collections were made in New York and in other Great Lakes states in the years immediately following these first records. Eurasian watermilfoil was found in Michigan in 1965 (Coffey and McNabb 1974) and in the St. C1air-Detroit River system in the 1960s (Schloesser and Manny 1984). Although the plant has not yet become a major problem in the Great Lakes, the abundance of Eurasian watermilfoil in the watershed has caused many problems. The extensive beds of the plant have created problems in recreational and industrial use of water, have competed with native aquatic plants, and can alter water temperatures (Aiken *et al* 1979). Such methods as cutting and harvesting, water drawdown, and herbicides, have been used to control the plant (Coffey and McNabb 1974). Eurasian watermilfoil most likely entered the Great Lakes basin through aquarium release and transport in or attached to boats or ships.

Trapaceae:

Trapa natans WATER CHESTNUT

The water chestnut was first introduced to North America in Concord, Massachusetts, before 1859 (Eaton 1947). This population became widely distributed and aggressive in the Concord and Sudbury rivers in Massachusetts (Eaton 1947). In the Hudson-Mohawk River drainage system, the plant was introduced into Sanders Lake in Scotia, New York (Wibbe 1886). Some authors credit this introduction to a "local sportsman" planting it as waterfowl food (Winne 1935, Anonymous 1938). The population at Sanders Lake, which is connected to the Mohawk River and Erie Canal system, spread into the Hudson-Mohawk drainage system and became a nuisance (Muenscher 1934). Muenscher (1935) later reported that the fruit was being sold at fairs in western New York and an aquarium plant dealer was selling the seeds. The first records of the water chestnut in the Great Lakes basin are unpublished. In two sites in central New York, Kendig Creek and Keuka Lake, mechanical control eliminated water chestnut populations by 1959 and the early 1970s, respectively. The plant is currently known, however, from Sodus Bay, Lake Ontario, where mechanical control has been practiced annually since the 1960s (W. Abraham, New York State Department of Environmental Conservation, personal communication, 1991). The water chestnut was probably released into the Great Lakes basin through aquaria or escape from private ponds. in areas of infestation, the tough stems and leaves of the plant impede boating, and the fruits of the water chestnut, which have four very sharp spines, are a nuisance to bathers (Anonymous 1938). Interestingly, the name *Trapa* was derived from the calci -

trapa, a four spined iron sphere which was used in Roman times to injure calvary horses' feet (Brown 1879, Anonymous 1938).

Menyanthaceae:

Nymphoides peltata YELLOW FLOATING HEART

The first records of the escape of this European plant from cultivation in North America were in the District of Columbia and in eastern New York (Fassett 1957). It is commonly used in ornamental ponds and garden pools and often gets out of control in nutrient rich pools (Muhlberg 1982). Stuckey (1973) reviewed its North American history and noted that the only known Great Lakes basin record is from 1930 in Ashtabula County, Ohio, at the mouth of the Conneaut River. The current status of this population is unknown (Stuckey 1973).

Hydrocharitaceae:

Hydrocharis morsus-ranae EUROPEAN FROG-BIT

Hydrocharis morsus-ranae, a floating aquatic plant, was imported into the Central Experimental Farm in Ottawa, Canada, from Zurich, Switzerland, in 1932 (Minshall 1940, Roberts *et al.* 1981). The species was planted in a trench connecting an arboretum pond to the Rideau Canal, but it was not observed until 1936 when it had invaded the pond (Minshall 1940). By 1953, frog-bit had gradually spread into the Rideau Canal, its connecting waters, and the Ottawa River and by 1958 it was well established in the St. Lawrence River near Montreal (Dore 1954, 1968). In 1972, *Hydrocharis morsus-ranae* was found in the Bay of Quinte, Lake Ontario, and in 1976 it was discovered in Rondeau Park on the north shore of Lake Erie (Catling and Dore 1982). Lumsden and McLachlin (1988) note the plant's continued spread into western Lake Ontario marshes. The plant will likely spread farther into the Great Lakes drainage. Although the primary introduction occurred through cultivation release, the spread of the species into the Great Lakes probably occurred through aquarium release, deliberate release as a food for waterfowl (Catling and Dore 1982), and entanglement on boats.

Potamogetonaceae:

Potamogeton crispus CURLY PONDWEED

Stuckey (1979) reviews the introduction and spread of this common European submersed aquatic plant into North America. Although reports of the species date back to 1807, the earliest verifiable records of the plant in North America are from the 1860s in Wilmington, Delaware, and Lancaster, Pennsylvania. In the 1880s, it was found in Arlington, Massachusetts. The first Great Lakes basin record is Keuka Lake, New York in 1879. By 1884 *Potamogeton crispus* was reported throughout central New York and near Niagara Falls. It is currently very common throughout the Great Lakes basin. It is more abundant in Lakes Ontario, Erie, and Michigan than in Lakes Superior and Huron, where it continues to spread. *Potamogeton crispus* is known to have been introduced into parts of the Great Lakes basin deliberately as food for waterfowl and has been associated with fish hatcheries, indicating potential transport between basins associated with fish stocking activities (Stuckey 1979).

Najadaceae:

Najas marina SPINY NAIAD

Spiny naiad, a plant preferring to grow in brackish and alkaline waters, was first found in North America in 1864 in central New York's Onondaga Lake near Salina, New York (Stuckey 1985). The plants were growing near a salt mine in brackish water. Soon after this initial record, the plant was discovered in other areas of central New York. Spiny naiad is also known from the western Great Lakes region where it invaded in the 1930s. Fossil records of this plant from the midwest indicate that it was present in North America prior to glaciation, supporting debate about whether the newly discovered populations were indigenous or non-native. Two interpretations of the plant's distribution in the Great Lakes have been outlined by Stuckey (1985). He theorizes that the plant was pushed south during glaciation and reinvaded glacial lakes when the ice receded. He suggests that the species persisted in areas where the habitat remained favorable and reinvaded some areas, such as the western Great Lakes region, more recently. The introduction of the plant from Europe or another region where it is common in habitats made brackish and alkaline by human activities (such as areas around salt mines) is also possible. Central New York was a very active botanical center in 1864 and the possibility that the plant was overlooked for years is unlikely. The area around Onondaga Lake has been industrialized since the early 1800s when humans began developing the salt resources around the lake. The salt from this area was transported into other parts of the United States and the salt industry had the power to instigate the construction of the Erie Canal (Murphy 1978). We consider the introduction

of spiny naiad into the industrialized area around Onondaga Lake to be a more likely scenario than the persistence of preglacial populations. Spiny naiad is now also known from Europe, Asia, Africa, Australia, South America, and Central America (Stuckey 1985).

Najas minor MINOR NAIAD

This European native was first found in North America in 1932 in Lake Cardinal, Ashtabula County, Ohio, in the Lake Erie drainage basin (Wentz and Stuckey 1971). In 1934 it was discovered in the Hudson River near Troy, New York (Clausen 1936). The plant was clearly established in this location in "great beds" in shallow water (Clausen 1936). In the same year, Muenscher and Clausen found populations of the plant growing in several different areas in and near the Hudson River (C1ausen 1936). The plant was soon introduced in 1935 at Ithaca, New York, by W.C. Muenscher, who wanted to see if it would persist in Cayuga Lake (Clausen 1936). After these original introductions, the plant rapidly spread into the Great Lakes system. It was identified in Monroe County, New York, in 1939 (Merilainen 1968), in Point Moullee State Game Area in Michigan in 1949 (Voss 1972), and by the late 1960s, it had become widespread throughout Ohio (Wentz and Stuckey 1971). Merilainen (1968) suggests bird migration and shipping as transfer mechanisms for this plant, but these mechanisms would apply to secondary dispersal after its initial introduction. The initial introduction mechanism for this plant into the Great Lakes at Cayuga Lake is deliberate release and into Lake Cardinal, Ohio, is unknown.

Marsh Plants

Chenopodiaceae:

Chenopodium glaucum OAK LEAVED GOOSE FOOT

Gray (1867) first reported this European plant from city streets and the brackish shores of Onondaga Lake near Syracuse, New York. Since then, it has been introduced or expanded into areas throughout the Great Lakes basin and is common in cultivated land, roadsides, shores and riverbanks, and marshy areas (Day 1882, Wiegand and Eames 1925. Montgomery 1957, Swink and Wilhelm 1979, Voss 1985). The spread of this plant into and throughout the Great Lakes region was probably mediated by railroads (Wiegand and Eames 1925, Voss 1985, Swink and Wilhelm 1979).

Caryophyllaceae:

Stellaria aquatica GIANT CHICKWEED

Britton and Brown (1913) recorded this European plant from Quebec and Ontario to Pennsylvania. Early Ontario records are from 1894 when the plant was found in Stratford, a town in the Lake St. Clair drainage (Montgomery 1957). Giant chickweed later became widely established in southern Ontario where it grew along the Thames River, Rideau River, Welland Canal, and in other areas (Montgomery 1957). The plant has become distributed throughout the Great Lakes basin (Zenkert and Zander 1975, Swink and Wilhelm 1979, Voss 1985, Gleason and Cronquist 1991). The mechanism through which this plant gained access to the Great Lakes remains unknown.

Polygonaceae:

Polygonum caespitosum var. longisetum BRISTLY LADY'S THUMB

Bristly lady's thumb, a rice paddy weed in Eastern Asia, was first discovered in North America in 1910 near Philadelphia (Kochman 1991). After its initial introduction, the plant spread to the south and the west. The first Great Lakes drainage records are from Erie County, Ohio, in 1960. The mechanism through which the plant was introduced remains unknown. Bristly lady's thumb is common in the Chicago area (Swink and Wilhelm 1979) and was first discovered in Michigan in 1978 (Voss 1985).

Polygonum persicaria LADY'S THUMB

Michaux (1803) noted *Polygonum persicaria* from Kentucky and by 1843 the plant was considered naturalized (Torrey 1843). Native to Europe, the marsh plant is found throughout-the Great Lakes basin in a variety of habitats (Day 1882, Dudley 1886, Wiegand and Eames 1925, Zenkert 1934, Fassett 1957, Montgomery 1957, Swink and Wilhelm 1979, Soper *et al* 1989). The mechanism through which it was introduced remains unknown.

Rumex longifolius YARD DOCK

Voss (1985) noted that *Rumex longifolius* and *Rumex domestics* are synonymous and reported records of the Eurasian plant from Isle Royle from 1901-1960. The 1901 date is the earliest validated date available even though an earlier record may exist, since some of the collections reported in Robinson and Fernald (1908) of *Rumex patientia* were actually *Rumex longifolius* (Fernald 1950). Robinson and Fernald (1908) reported *Rumex pati-*

entia from Newfoundland, New York, and Pennsylvania and a variety from Michigan, Montana, and westward. Britton and Brown (1913) reported *Rumex patientia* from various localities on the east coast and in the mid-west. Gray (1889) noted *Rumex patientia* from New England and New York. The plant is occasionally cultivated (Usher 1974).

Rumex obtusifolius BIITER DOCK

Bitter dock, a European plant known from rich, moist habitat, has been reported from the Great Lakes drainage since the earliest botanical surveys of the region (Voss 1985). In Michigan, it was discovered in the first survey, which occurred between 1837 and 1840 (Voss 1985). Also common in New York during this period (Torrey 1843), the weedy species has spread throughout the Great Lakes region in many moist, disturbed habitats (Dudley 1886, Wiegand and Eames 1925, Fassett 1957, Swink and Wilheim 1979, Voss 1985).

Brassicaceae:

Rorippa sylvestris CREEPING YELLOW CRESS

This European native was first reported in North America from Philadelphia in 1818 (Stuckey 1966). In the early 1890s, it was also found in the Chicago area, but these records were in the Mississippi drainage basin despite their proximity (15 to 20 km) to Lake Michigan (Hill 1892). The first observations of creeping yellow cress in the Great Lakes drainage were from 1884 in Rochester, New York. After these first introductions, the plant spread quickly into many areas of the Great Lakes region (Stuckey 1966). The collection of the plant on solid ballast dumping grounds in Mobile, Alabama, in 1883 indicates its potential for introduction with solid ballast (Stuckey 1966). Stuckey (1966) suggested that, due to the distance between the Great Lakes populations and those in eastern ports, the introduction of creeping yellow cress into the Great Lakes basin was directly from Europe. The plant is known from shores and other wet habitat (Fassett 1957, Voss 1985).

Primulaceae:

Lysimachia nummularia MONEYWORT

in central and western New York, moneywort was first reported by Dudley (1886) and Day (1882), and by the 1920s it had become naturalized throughout the area in ditches and on stream banks (Wiegand and Eames 1925, Zenkert 1934). The plant, a native of Europe, is known to have escaped from gardens in many areas of northeast North America and the Great Lakes basin (Fernald 1950, Swink and Wilhelm 1979). Usher (1974) noted that the leaves of moneywort have been used to heal wounds and can be ingested as tea.

Lysimachia vulgaris GARDEN LOOSESTRIFE

This ornamental Eurasian plant was first known to escape from cultivation in eastern Massachusetts between 1867 and 1889 (Gray 1867, 1889). By 1913, it was observed from Maine to Ontario, southern New York, and Pennsylvania (Britton and Brown 1913). Although specific locations for the Ontario observations are unknown, they were probably in the Great Lakes drainage since many of the major population centers in Ontario at the turn of the twentieth century were Great Lakes ports. Montgomery (1957) noted that the plant occasionally escapes from cultivation. Garden loosestrife can be used as an astringent and to treat bleeding (Usher 1974). Several large populations in mudflats and shallow water exist in the Chicago area (Swink and Wilhelm 1979). Zenkert (1934) also recorded the species from near Buffalo, New York, in 1921.

Lythraceae:

Lythrum salicaria PURPLE LOOSESTRIFE

Thompson *et al.* (1987), Stuckey (1980), and Mal *et al.* (1992) reviewed the introduction and spread of purple loosestrife into North America and Canada. Purple loosestrife is thought to have been introduced to Atlantic Coast ports in the early 1800s with imported sheep, in solid ballast, or as a cultivated plant. The first record of purple loosestrife in the Great Lakes basin is from 1869 in Ithaca, New York (Dudley 1886). Although it was reported in the earliest Michigan botanical surveys, the first herbarium collections are from 1879 (Voss 1985). The plant is thought to have spread into the Great Lakes basin through railroads and along canals. The rapid spread of this wetland species throughout the United States and Canada occurred after its initial invasion of the Great Lakes (Thompson *et al.* 1987). The ecological impacts associated with often monospecific stands of purple loosestrife are their competitive effects on native plants (cattails and other species) and the loss of prime habitat for waterfowl and other marsh animals (Rawinski and Malecki 1984).

Onagraceae:

Epilobium hirsutum GREAT HAIRY WILLOW HERB

The first records for this Eurasian marsh species in North America are from Newport, Rhode Island, in 1829. Early records show it from cultivated ground and on solid ballast grounds (Stuckey 1970). The first record in the Great Lakes basin is from 1874 near a mill west of Cascadilla Place in Ithaca, New York (Dudley 1886). In 1882 the plant was observed from Clifton, Ontario and later, in 1890, it was collected in Niagara Falls (Stuckey 1970). The Niagara Falls specimens are thought to have been introduced with garden seed. By 1948, the plant had spread into the Great Lakes basin as far as Cook County, Illinois (Stuckey 1970).

Epilobium parviflorum SMALL FLOWERED HAIRY WILLOW HERB

The earliest known North American record for *Epilobium parviflorum* is from solid ballast ground at Hoboken, New Jersey (Trelease 1891). It was not reported again until Purcell (1976) found it in Toronto, Ontario, in 1973. On finding the species in Ontario, Purcell examined herbarium specimens of *Epilobium hirsutum* and found many of them to be misidentified specimens of *Epilobium parviflorum.* From this study, eight localities containing this plant in Ontario were found, the earliest being from 1969 in Midland, Ontario (Purcell 1976). Voss (1985), however, reported *Epilobium parviflorum* in Benzie County, Michigan, as early as 1966. The Michigan record is the earliest known collection of the plant in the Great Lakes drainage but how the plant was introduced remains unknown (Purcell 1976).

Apiaceae:

Conium maculatum POISON HEMLOCK

This highly poisonous plant, once valued medicinally as a powerful narcotic, was established in eastern North America by the early 1800s (Nuttall 1818, Torrey 1843). By 1843, the plant was established in many areas of New York state, probably including the Lake Ontario drainage (Torrey 1843), and by the 1890s it was established in Michigan (Voss 1985). A native of Europe, poison hemlock is common in waste places, on stream banks, and in other damp areas in the Great Lakes region (Dudley 1886, Wiegand and Eames 1925, Montgomery 1957, and Voss 1985).

Solanaceae:

Solarium dulcamara BITTERSWEET NIGHTSHADE

Early settlers imported this European plant that was becoming naturalized by the early 1800s (Nuttall 1818); in colonial times it was used as a remedy for scurvy and rheumatism (Torrey 1843). Although its early distributional history in the Great Lakes is obscure, the plant was widely distributed in New York State and probably in the Great Lakes basin by 1843 (Torrey 1843). The plant is common in lowlands and swamps (Fassett 1957) throughout the Great Lakes basin (Dudley 1886, Swink and Wilhelm 1979, Soper *et al*. 1989).

Boraginaceae:

Myosotis scorpioides TRUE FORGET-ME-NOT

An ornamental and medicinal plant escaping from cultivation, the European forget-me-not is a common and widespread member of the Great Lakes flora. Early records of the plant in North America date to the earliest flora (Nuttall 1818, Torrey 1824), but later records note that a native species was misidentified as the European one. By 1867, early records of the European species escaping from gardens were documented in the Boston area and by 1889 the plant was widely distributed (Gray 1867, 1889). In the Great Lakes drainage the plant is recorded by Dudley (1886) from Ithaca, New York. Known from wet habitats and sometimes shallow water, it is now very common from Lake Superior (Soper *et al.* 1989) to central New York (Zenkert 1934).

Lamiaceae:

Lycopus asper WESTERN WATER HOREHOUND

This plant is thought to have been introduced into the Great Lakes from the Mississippi River drainage basin. Stuckey (1969) reviewed the distributional history of *Lycopus asper* in western Lake Erie and Lake St. Clair. Using the wealth of historical botanical data for the region, Stuckey concluded that the *Lycopus asper* populations in the region are non-indigenous. Swink and Wilhelm (1979) consider this species adventive and record it from industrialized areas, polluted habitat, and other man-made habitats. Although records of the plant in other parts of the Great Lakes region are not supported by the historical distributional data that the western Lake Erie data provide, botanists generally agree that the plant has been introduced into the Great Lakes watershed. In western Lake Erie, the

earliest records of the plant are from 1892 at Port Huron .*Lycopus aspe* is thought to have been transported with grain into the Great Lakes basin in the late 19th century.

Lycopus europaeus EUROPEAN WATER HOREHOUND

The first two North American records for this plant are from Norfolk, Virginia, around 1860 and from solid ballast ground in the Delaware River in New Jersey in 1867 (Stuckey and Phillips 1970). Many of the early collections of this plant came from ballast grounds or from port areas. In New York City, the plant was a well documented solid ballast introduction (Brown 1879). in 1903 ,*Lycopus europaeu s* was found in Lake Ontario on Toronto Island. The plant has since spread into the western edge of Lake Erie, through Lake Ontario into the St. Lawrence River (Stuckey and Phillips 1970). The distributional history of the Great Lakes populations indicates that they are not the result of a spread into the watershed from Atlantic populations but represent a separate introduction from Atlantic ports or Europe (Stuckey and Phillips 1970).

Mentha spp. MINTS

Hybrids between and among the native and introduced mint species have resulted from the introduction of mints from Europe. Because of the hybridizations, the taxonomy of the genus is complex and has changed many times in the past 150 years. The determination of which mint species have been introduced into the Great Lakes watershed from Europe and the details of their introductions, therefore, must be accomplished through herbarium specimen examination and is beyond the scope of this study. Listed below are three of the more prominent species of mint that are known from marsh habitats in the Great Lakes basin.

Mentha gentilis CREEPING WHORLED MINT

Gray (1867) noted this mint from river banks in Lancaster, Pennsylvania, and later (Gray 1889) gave it a distribution from Massachusetts to Pennsylvania. Britton and Brown (1913) described its distribution from Nova Scotia to northern New York, Iowa, North Carolina, and Tennessee. Wiegand and Eames (1925) reported the plant as rare and have records from 1915 and 1917 in the Cayuga Lake basin in central New York. In 1922 and 1924, it had escaped from cultivation in the Buffalo, New York area (Zenkect 1934). This plant is thought to be a hybrid of *Mentha spicata* and *Mentha arvensis,* the only native North American mint (Fernald 1950, Gleason and Cronquist 1991). If this is so, it would account for its rare and sporadic occurrence.

Mentha piperita PEPPERMINT

Torrey (1843) reported this mint from moist ground and river shores from the Hudson River and Western New York. Gray (1867) reported that the mint became naturalized quickly because of its use of underground shoots for asexual propagation. Gray (1889) noted that the mint was "everywhere" along brooks. This mint is a sterile hybrid of *Mentha spicata* and *Mentha aquatica* and is cultivated for peppermint oil (Usher 1974).

Mentha spicata SPEARMINT

Torrey (1843) and Gray (1848) noted this species as "perfectly naturalized" in wet meadows and on stream margins. Because the plant was so widespread in 1843, introduction probably occurred long before this date. This species is known from damp or wet habitats in the Great Lakes region (Dudley 1886, Swink and Wilhelm 1979). This mint is the source of spearmint oil and has been used medicinally (Usher 1974).

Scrophulariaceae:

Veronica beccabunga EUROPEAN BROOKLIME

Veronica beccabunga was first observed in North America in 1876 in Hudson County, New Jersey, at the Bergen Tunnel (Les and Stuckey 1985). An early record from solid ballast ground at Hunter's Point, Long Island, New York in 1880, indicated that the plant was introduced in the solid ballast of ocean-going ships arriving from Eurasia. The first observation of European brooklmne in the Great Lakes watershed is from Irondequoit, New York (Monroe County), in a wet meadow in 1915. The plant is currently distributed in northeastern North America from Michigan and Ohio to the St. Lawrence River in Quebec. Several subspecies of the plant occur. Studies of these species show that the plants present in eastern North America are of the *beccabung a* subspecies which is distributed in Europe (Les and Stuckey 1985). In the past, this plant was occasionally used to treat scurvy (Usher 1974).

Asteraceae:

Cirsium palustre MARSH THISTLE

Britton and Brown (1913) treated the marsh thistle as a species introduced from Europe and cited

only one population, in East Andover, New Hampshire. Fernald (1950) indicated that this plant is indigenous to Newfoundland and "partly adventive" from Nova Scotia to Northern Michigan. Gleason and Cronquist (1991) however, note that the plant is widely introduced into the United States and Canada but can seem "native" when it invades forests. The plant has been introduced into the marshes around Lake Superior (A. Reznicek, University of Michigan Herbarium, personal communication, 1990).

Pluchea odorata SALT-MARSH FLEABANE

var. *succulenta*

This variety of *Pluchea odorata,* an eastern coastal marsh species, is known in the Great Lakes basin from areas of southern Ontario affected by brine from salt deposits, mines, and factories (Catling and McKay 1980), from western New York (Fernald 1950), and from the Chicago area (Swink and Wilhelm 1979). Zenkert (1934) did not note this plant in hi s*Flora of the Niagara Frontier Region* ,which included most of western New York. The plant was probably introduced into the Great Lakes drainage in western New York between 1933 and 1950.

Pluchea odorata SALT-MARSH FLEABANE

var. *purpurescens*

This variety is known from an area around a salt mine in Michigan near Detroit (Frwvell 1916, Fernald 1950). Farwell's (1916) reports of *Pluchea camphorat e* from Michigan must have been *Pluchea odorata* var. *purpurescen s* because the plants are similar and Femald (1950) cited distributions for *Pluchea odorata* var. *purpurescen s* in Michigan. Farwell (1916) suggested that these plants were imported with rail way freight and survived high salt content in areas adjacent to salt mines.

Solidago sempervirens SEASIDE GOLDENROD

The first inland records for this Atlantic coastal species are from the Chicago area in 1969 (Swink 1969). The plant is common in industrialized parts of Chicago and other areas (Swink and Wilhelm 1979). In 1974, the plant was also found near Windsor, Ontario, in areas near salt mines and salt processing plants (Catling and McKay 1980). These two populations represent the only known successfully established inland sites for seaside goldenrod.

Sonchus arvensis FIELD SOW THISTLE

Torrey (1843) noted this aggressive European species from Staten Island. New York, near [he quarantine area, possibly indicating an introduction with animal bedding or forage. Between 1863 and 1865, the plant was identified from Cayuga Lake, New York, and Rochester, New York (Dudley 1886). The plant has become widespread in the Great Lakes basin (Zenkert 1934, Britton and Brown 1913, Deam 1940).

Sonchus arvensis SMOOTH FIELD SOW THISTLE

var. ***glabrescent***

The earliest records for smooth field sow thistle in the Great Lakes basin are from Erie County, Ohio, in 1902 and from Ithaca, New York, in 1916 (Long 1922). The taxonomy of these specimens. however, is questionable (Long 1922, Wiegand and Eames 1925). Zenkert (1934) noted that this variety of the European common field sow thistle was most likely "more recently" imported with grain from the northwest into the Buffalo, New York, region. It was not included in Britton and Brown (1913). Fernald (1950) noted it from locations throughout northeastern North America.

Butomaceae:

Butomus umbellatus FLOWERING RUSH

This European marsh species was observed in North America in La Prairie, Quebec. a town across the St. Lawrence River from Montreal, in 1897 and first collected there in 1905 (Core 1941). In 1930, collections of the plant were made in the vicinity of the town of River Rouge, south of Detroit, Michigan, along the Detroit River (Farwell 1938). The plant quickly spread and became established along a large part of the St. Lawrence River and in localities in Ontario and New York (Gaiser 1949). In many cases the spread of flowering rush after its initial introduction is due to deliberate introductions (Gaiser 1949). The over 800 km disjunct distribution from the nearest population in Quebec to the population in Michigan indicates that the Michigan population was derived either from the La Prairie population or directly from Europe (Stuckey 1968). Montreal was a port where cargo was transferred from ocean going ships to lake ships until the canal system was expanded to accommodate larger vessels. Because this practice was much more common than a direct sail through existing canals that would limit ship size, *Butomus umbellatus* was probably released by a lake ship from Montreal. The intro-

duction into Detroit must have occurred earlier than the 1930 collections suggest because Farwell knew of observations of a large population of the plant in the River Rouge area before 1918. These populations were diminished when Ford Motor Company apparently reclaimed the marshland where these immense stands of flowering rush had occurred (Farwell 1938). The introduction of *Butomus umbellarus* with shipping activities into Montreal and Detroit is likely, although it is known to have been used as a local food source in Russia (Usher 1974). Other theories concerning the introduction of flowering rush into North America date it much earlier. Farwell (1938) suggested that the introduction could have occurred as early as the mid 1600s. Stuckey (1968) however, noted that the rate that the populations have spread after their initial discovery was more characteristic of a recently invading species.

Balsaminaceae

Impatiens glandulifera INDIAN BALSAM

Voss (1985) reported three Michigan records for this Himalayan ornamental plant: from Port Huron in 1912, Sugar Island in 1956, and on Lake Superior at Grand Marais in 1984. Indian balsam is also known from aquatic habitats in southwestern Thunder Bay and Thunder Cape on Lake Superior (Soper *et al.* 1989). Fernald (1950) reported the plant from several northeastern Canadian provinces, including Ontario, and New England. This species is also known to be highly invasive in disturbed or polluted sites in the British Isles (Usher 1986).

Juncaceae:

Juncus compresses FLATTENED RUSH

Stuckey (1981) reviewed the introduction of the Eurasian flattened rush into North America. Although Bartlett (1906) first reported its presence in North America from 1904 collections, *Juncus cumpressus* was misidentified as *Juncus gerardii* prior to 1904 (Stuckey 1980). According to Stuckey, Marie-Victorin (1929) believed that *Juncus compresses* was brought to North America in forage used to feed military horses. A species favoring brackish, calcareous marshes (Gleason and Cronquist 1991), its introduction into locations in the interior often can be associated with commerce and disturbed man-made areas. For example, prior to 1895, the rush was observed near Cayuga Lake at a glass factory and around a railroad station within the Cayuga Lake drainage basin (Wiegand and Eames 1925). Wiegand and Eames (1925) believed the plant had been brought to the lake with the sand used in manufacturing the glass. Flattened rush is also known from the Toronto, Ontario, area (Stuckey 1980).

Juncus gerardii BLACK-GRASS RUSH

Black-grass tush, a dominant salt marsh species, is found on the Atlantic and Pacific coasts and has invaded inland habitats (Muenscher 1944, Stuckey 1980, Zenkert 1934). The earliest known Great Lakes records of the plant are from saline marshes in Salina, New York, in 1864 and near Chicago in 1862 (Stuckey 1980). Because its occurrence inland is associated with man-made, often saline habitats, it is probable that the introduction of the plant was aided by commerce. The occurrence of the rush on ballast grounds and its use as packaging material support this argument. The plant is known from Lakes Ontario, Erie, Huron. and Michigan (Stuckey 1980).

Juncus inflexus RUSH

Juncus inflexus was first found in North America near Sangerfleld and Waterville, New York in 1917 in the Mohawk-Hudson River drainage basin. The plant was well established in the "boggy" and "springy" habitat at this locality and probably had been introduced many years before its discovery (Clarke and House 1921). Clarke and House (1921) noted that the site had never been cultivated but had earlier been used for pasturage. In 1922, the plant was discovered in the Great Lakes basin in Ithaca, New York (Wiegand and Eames 1925). Farwell (1941, 1945) reported a population of this European species in 1936 near Hancock, Michigan, and Voss (1972) noted that this population persisted in 1958. The means through which this plant was introduced remains unknown.

Cyperaceae:

Carex acutiformis SWAMP SEDGE

Carex acutiformis, a Eurasian and African sedge, was first discovered in North America in 1865 in eastern Massachusetts (Hermann 1952). In 1951, the plant was found on the shores of St. Joseph Lake, Notre Dame, Indiana (Hermann 1952). By 1976, the population in Indiana had increased in abundance (Swink and Wilhelm 1979). The means through which it was introduced remain unknown.

Carex disticha SEDGE

The first North American records for *C. disticha,* a Eurasian sedge known from swamps, wet meadows and prairies, and fens, are from Belleville, Ontario.