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Exotic Species in the Great Lakes: A History of Biotic Crises and Anthropogenic Introductions

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ABSTRACT. *Through literature review, we documented introductions of non-indigenous aquatic flora and fauna into the Great Lakes basin since the early 1800s. We focused on the origin, probable mechanism(s) of introduction, and the date and locality of first discovery of Great Lakes exotic species. The Laurentian Great Lakes have been subject to invasion by exotic species since settlement of the region by Europeans. Since the 1800s, 139 non-indigenous aquatic organisms have become established in the Great Lakes. The bulk of these organisms has been represented by plants (59), fishes (25), algae (24), and mollusks (14). Most species are native to Eurasia (55%) and the Atlantic Coast (13%). As human activity has increased in the Great Lakes watershed, the rate of introduction of exotic species has increased. Almost one-third of the organisms have been introduced in the past 30 years, a surge coinciding with the opening of the St. Lawrence Seaway in 1959. Five categories of entry mechanisms were identified: unintentional releases, ship-related introductions, deliberate releases, entry through or along canals, and movement along railroads and highways. Entry mechanisms were dominated by unintentional releases (29%) and ships (29%). Unintentional releases included escapees from cultivation and aquaculture, bait, aquarium, and other accidental releases. Ship-related introductions included ballast water (63%), solid ballast (31%), and fouling. Introductions via canals represent a small percentage of entries into the Great Lakes. We have identified 13 non-indigenous species (9%) that have substantially influenced the Great Lakes ecosystem, both economically and ecologically. The apparent lack of effects of 91% of the exotic species*

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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

BITTER 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 Wilhelm 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).