

Aquatic Invaders and the Great Lakes: Simple Questions, Complex Answers

How many aquatic non-native (nonindigenous, exotic) species are there in the Great Lakes?

(From information and text provided by Prof. A. Ricciardi, McGill University, Canada).

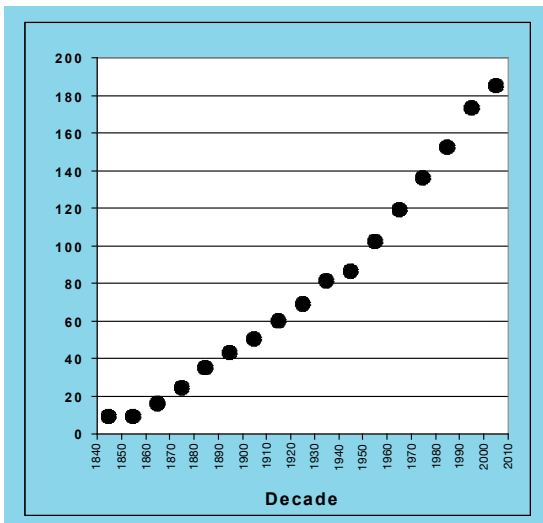
The earliest record of a species not native to any part of the Great Lakes Basin is bitter dock (*Rumex obtusifolius*), a vascular invasive plant first reported in 1840 and native to Europe. Extensive literature reviews have documented ~185 aquatic invaders established in the Great Lakes as of May 2007, representing fishes, invertebrates, aquatic plants, algae, and pathogens. This number is best interpreted as a minimum, as it does not include species that are native to part of the basin and invasive in other parts (e.g., sea lamprey, rusty crawfish). The total number of non-native species listed as being established (i.e. having a sustainable reproducing population) within the Great Lakes basin cannot be known with absolute precision, because identification depends on our ability to find, recognize, verify, and document new species, which is, in turn, dependent on our ability to sample the system, and how often we sample it.

While all of these ~185 species are invaders - not native to the Great Lakes, not all are considered "invasive" (species that have established sustained populations and that can or do harm the ecosystem, economy, or human health). Key examples of "invasive" species in the Great Lakes are viral hemorrhagic septicemia (VHS), the zebra and quagga mussels, round goby, spiny and fishhook waterfleas, ruffe, and Eurasian watermilfoil.

How are nonindigenous species getting into the Great Lakes?

Ships' ballast tanks have been the major vector for non-native species introductions to the Great Lakes. From 1960, the year

Time-series of aquatic invaders discovered in the Great Lakes since 1840, by decades.

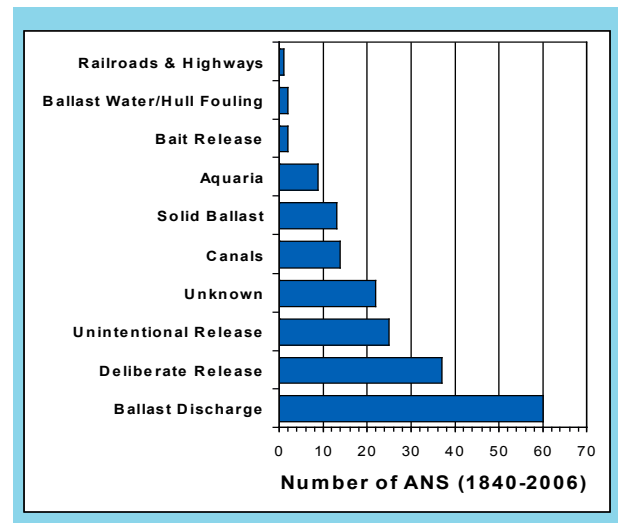


after the St. Lawrence Seaway opened, through 2006, ~64% of established aquatic invaders discovered in the Great Lakes are attributed to ballast discharge. Recent research suggests that the residual water and mud found in many "empty" ballast tanks (i.e., no-ballast-on-board" or "NOBOB" tanks) is also a potential source for species invasions. Hull fouling is not thought to be a significant vector for new introductions to the Great Lakes, because most freshwater fouling organisms are not likely to survive prolonged exposure to salt water during transoceanic voyages. Deliberate releases made the second largest contribution, primarily from releases related to cultivation and fish stocking. Canals connecting watersheds and river systems were responsible for some significant historical introductions such as alewife and white perch, as well as a number of snails. Three species of Asian carp (silver, black, and bighead) that are moving up the Mississippi River system potentially have access to Lake Michigan via the Chicago Sanitary and Ship Canal. Millions of federal and state dollars are being invested in electric barriers designed to keep the fish from moving into the Lakes.

What effect are these organisms having on the Great Lakes?

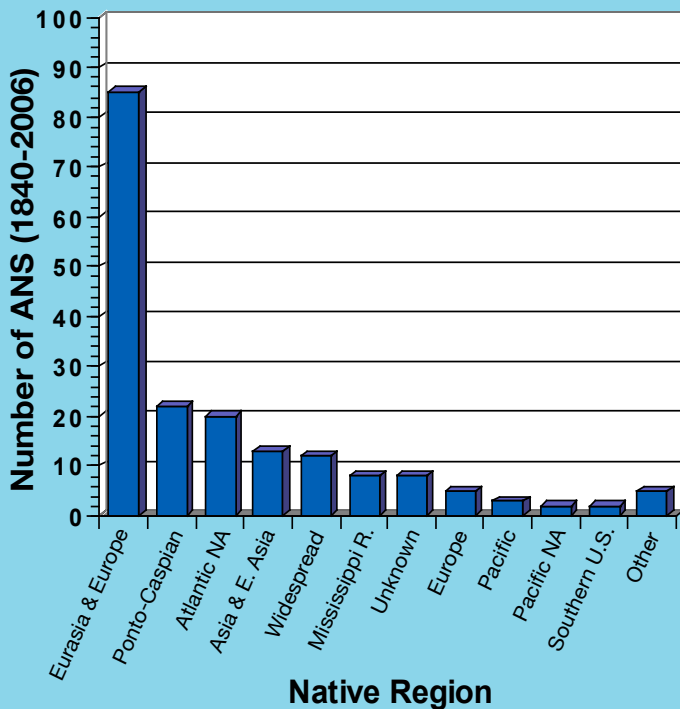
There have been major impacts on the Great Lakes ecosystem that appear to be directly, and indirectly, linked to some ANS. These impacts affect both the commercial and recreational resources for which the Great Lakes are best known. Examples include:

- Clogging of fishing nets by the fishhook waterflea increases costs for commercial fishermen.
- Eurasian watermilfoil interferes with swimming, fishing, water skiing, and boating. The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes.



Activities (vectors) that have introduced non-native species to the Great Lakes.

Where are these organisms (species) coming from?



Native regions of aquatic invaders found in the Great Lakes.

The majority of aquatic species that have invaded the Great Lakes have native ranges in Eurasia (Europe plus Asia) or in Europe. A subset of Eurasian species that are native to the Ponto-Caspian basins (Black, Caspian, and Azov Seas) of Eastern Europe have been remarkably successful in the Great Lakes, especially over the last 25 years. From 1980 to 1992, 7 of 20 newly discovered species attributed to ballast water were Ponto-Caspian natives, while from 1994 to 2006, 10 of 14 newly discovered species attributed to ballast water were Ponto-Caspian natives. Prominent among them are zebra and quagga mussels, round gobies, fishhook waterflea, Echinogammarus amphipods, and the most recent (2006) invader, the bloody red shrimp. Ponto-Caspian taxa now constitute a very significant component of the biomass and productivity of Great Lakes' food webs. Coastal North Atlantic is the third largest known source for nonindigenous species in the Great Lakes. Examples of ANS from this region include alewife, blueback herring, and the devastating fish virus, VHS.



Zebra mussels attach to the shells of native mussels, prohibiting them from feeding.

- Quagga mussels appear to promote the growth of the bacteria responsible for type E botulism and to concentrate the botulism toxin. More than 52,000 waterbird deaths were attributed to Type E botulism from 2002 to 2006 on the Great Lakes.
- Lake whitefish are less robust (and lower in economic value), probably due to the decline in *Diporeia*, a small shrimp-like organism that has been their primary food. *Diporeia* declines are associated with the invasion of zebra and quagga mussels. Declines in the yellow perch population in Lake Michigan likewise appear to be associated with one or more invasive species.
- Round gobies vigorously defend spawning sites in rocky or gravel habitats, thereby restricting access of native fish to prime spawning areas.
- As viral hemorrhagic septicemia (VHS), a 2005 discovery, spreads among fish populations, potentially devastating fishery and related economic losses are feared.

What is GLERL's Scientific Program and Other Activities Related to the Aquatic Invaders Issue?

GLERL's research targets two critical areas related to Great Lakes invaders: (1) prevention and control to stop the inflow and spread of new aquatic organisms, particularly via ship ballast, and (2) understanding and minimizing ecological impacts of species invasions through ecosystem modeling and forecasting. Details of GLERL's current research program and activities can be found at <http://www.glerl.noaa.gov/res/Programs/ais/>

Partnerships and scientific collaborations are an important component of GLERL's research programs. Partners involved with our aquatic invaders research are international in scope, and include scientists from many universities, government agencies, and foreign research institutions.

GLERL is home to the NOAA National Center for Research on Aquatic Invasive Species <http://www.glerl.noaa.gov/res/Programs/ncrais> and also represents NOAA on the Great Lakes Panel on Aquatic Nuisance Species.

GLERL scientists also interact with various stakeholders on invasive species issues, such as the International Joint Commission, the International Association for Great Lakes Research, other Federal and state agencies, and the news media.

For more information on this or other GLERL research projects, please contact:

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