Invasive Species of Lakes Erie and Ontario

by

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Fact Sheet

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Introduction

An unusual form of pollution is impacting Lakes Erie and Ontario but has nothing to do with industrial discharges, municipal sewage or chemical rain. Instead, this pollution is in the form of non-native plants and animals that have entered the Great Lakes ecosystem and caused dramatic changes. These species go by many names: exotic, nonindigenous, invasive, nuisance. But, by whatever name they are called, these are species that have been transported, most often by human activities – intentionally or unintentionally – into a geographic region outside their native range and are now reproducing in the wild in their new environment. An ability to spread throughout an ecosystem, limiting food and habitat and competing with or even displacing native species, has earned the name *invasive species*. Because these species often have harmful impacts on their new home, they are often referred to as *aquatic nuisance species*. In the rest of this publication, we will use the term *invasive species*, with the understanding that the species highlighted are invasive, nonindigenous, and nuisances.

Invasive species have been called biological pollution due to their ability to negatively impact the ecosystem and the native populations of flora and fauna that it supports. The combined effect of these species has been to change the food webs in Lakes Erie and Ontario, as well as to alter trophic levels from the lowliest plankton to the top predatory fishes. Aquatic invaders can have a catastrophic impact on the ecosystem by displacing native species, sometimes to the point of local extinction (extirpation), thereby reducing biological diversity. For example, several native species of mussels in Lake St. Clair have been exterpated, and populations in some areas of Lake Erie are jeopardized, by the zebra mussel. The ecological and economic impact of invasive species should not be minimized. In fact, the impacts of invasive species are seen by many scientists to be as great a threat as, if not greater than, loss of habitat in the Great Lakes.

Invasive species in the Great Lakes include fishes, mollusks, crustaceans, other invertebrates and plants, as well as disease-carrying organisms, and have been entering the lakes since the advent of canals in the early-1800s. The opening of the St. Lawrence Seaway in the late-1950s, allowing large, ocean-going ships to enter the Great Lakes carrying millions of gallons of freshwater ballast water – which can contain a multitude of invasive species – accelerated this process.

More than 145 different plants and animals have invaded the Great Lakes in the past 200 years. Some of these, such as the sea lamprey and the zebra mussel, have had economic as well as ecological impacts. The Great Lakes have been especially hard hit by the invasion of invasive species due to the presence of numerous canals and international ship traffic. Ballast water transfers from such ships have introduced invasive species such as zebra and quagga mussels, spiny waterfleas, Eurasian ruffe and the round goby.

The construction of the Erie Canal (officially opened in 1825) served as a major pathway for invasive species introductions from the Atlantic Ocean and the Hudson River into the Great Lakes via Lake Ontario. Niagara Falls historically served as an impenetrable barrier to the dispersal of invasive species from Lake Ontario to Lake Erie and the upper Great Lakes. The construction of the Welland Canal (opened in 1829 and enlarged in 1919) served to link Lake Ontario to the upper lakes, providing an invasive species bypass around the falls. Another important pathway was the opening of the St. Lawrence Seaway in 1959, which greatly enhanced large ship traffic into the Great Lakes and provided an avenue for introductions of invasive aquatic species from across the globe.

Some introductions of invasive plants and animals, however, had no links to canals or shipping. A number of invasive species entered the Great Lakes through the release of aquarium pets, fish aquaculture operations, bait-bucket releases and even intentional releases that proved to be environmental mistakes. The common carp is an example of an intentional release that went awry. Common carp were originally stocked to increase potential food resources for immigrants to the Great Lakes region. Once released to natural environments, these benthic fishes uprooted native aquatic vegetation, caused excessive turbidity and competed with native fish for food and habitat. In some cases, stocking of nonindigenous fish was implemented to control the spread of other invasive species such as alewives and smelt. While the stocking of Pacific salmonids has successfully reduced the numbers of those nonindigenous forage fishes, such introductions have contributed significantly to the overall artificiality of the modern Great Lakes ecosystem.

Invasive Species of Lakes Erie and Ontario

Zebra Mussel (*Dreissena polymorpha*) and Quagga Mussel (*Dreissena bugensis*)

During the late 1980s, zebra and quagga mussels were introduced into the Great Lakes as veligers (larvae) from freshwater ballast discharged from freighters that originated in the Black and Caspian Sea regions of eastern Europe and western Asia. These small, bivalve mussels have the ability to filter huge amounts of water (up to two liters per day per adult mussel) in order to draw in the plankton they use as food. Zebra and quagga mussels primarily consume phytoplankton (microscopic plant life) which forms the base of the aquatic food chain, although they can also consume small zooplankton (tiny aquatic animals) and bacteria. This filtering, and subsequent removal of plankton from the lakes, has created a dramatic increase in water clarity. Although the clearer lake water is seen as an aesthetic benefit to some, the loss of nutrients it represents significantly reduces the food that is available for fish and other organisms.

D. Schloesser

Zebra and quagga mussels are referred to as *biofoulers* because of their ability to attach to solid underwater substrate, like rocks, piers, intake pipes, and boat hulls using tough elastic strands called *byssal threads*. In addition to the ecological damage they cause, hundreds of millions of dollars have been spent to clean up fouled pipes and keep the mussels from fouling drinking water treatment, industrial and power plant intakes.

Zebra and quagga mussels have spread beyond the Great Lakes region, reaching as far down the Mississippi River as New Orleans, Louisiana. A female mussel can produce up to 1,000,000 eggs per year and the veligers are dispersed by waves and water currents. The veligers settle out of the water column, attach, and form colonies up to several hundred thousand mussels per square meter (1.2 square yards).

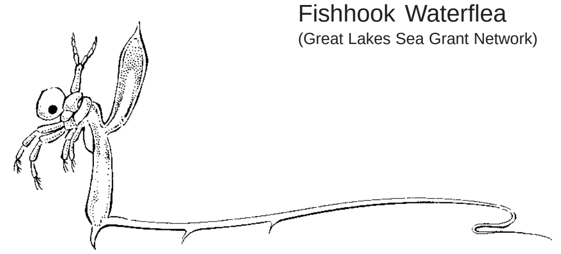
Although quagga mussels are similar to zebra mussels, they have the ability to survive in deeper, colder water than zebra mussels and, in areas with low concentration of plankton, can survive on bacteria better than zebra mussels. In many areas of Lakes Erie and Ontario, the original settlements of zebra mussels have been displaced by quagga mussels.

Spiny Waterflea (*Bythotrephes cederstroemi*) and Fishhook Waterflea (*Cercopagis pengoi*)

Although one of the smallest invaders (5 - 15 mm), the spiny waterflea, also known as "B.C.", has had a big impact on the Lake Erie ecosystem. These tiny invertebrates are not insects, but small, predatory crustaceans with a long, barbed tail spine that protects them from predators while they compete with fishes, like young yellow perch, for zooplankton. A native to Great Britain and northern Europe, spiny waterfleas were first discovered in Lake Ontario in 1982. These creatures entered the lakes via ballast water discharges and spread to all five Great Lakes within a few years. They are able to reproduce rapidly; during warm summer months, each female can produce up to 10 offspring every two weeks.

Spiny Waterflea
(Great Lakes Sea Grant Network)

Scientists are now concerned about a similar species, commonly called the fishhook waterflea, that was found in Lake Ontario in 1998. Within four years, *C. pengoi* has spread to Lakes Erie and Michigan and the Finger Lakes. Many researchers theorize that the fishhook waterflea has the potential to have greater impacts on Lakes Erie and Ontario food webs than has the spiny waterflea. Both species of waterfleas are a nuisance to anglers, who often find cotton-like globs of the creatures on fishing lines and nets. Some anglers have had to cut their lines and lose fish. The food web impacts (energy sink or source) are still unknown.



Fishhook Waterflea
(Great Lakes Sea Grant Network)

Sea Lamprey (*Petromyzon marinus*)

The sea lamprey is a predatory, eel-like fish, native to the coastal regions of the Atlantic Ocean. It was first discovered in Lake Ontario in the 1830s, and is thought to have migrated from its native habitat in the Atlantic drainage from the Hudson River through the Erie Canal or by attaching itself to boats plying the Erie and St. Lawrence Canal systems. The lamprey did not arrive in Lake Erie until 1921, two years after the enlargement of the Welland Canal. Fortunately, Lake Erie does not have the same high populations of sea lampreys as the larger, deeper lakes.

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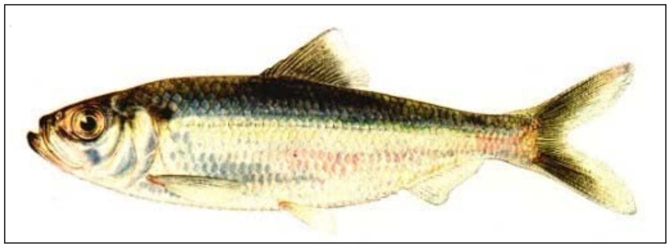
Great Lakes Fishery Commission

The sea lamprey attaches itself to the sides of its target fish (important sportfish such as trout and salmon) using a sucking disk, while sharp teeth in its circular mouth cut through the skin of the fish. The lamprey then sucks the blood and body fluids from the fish. Often pictured firmly attached to the sides of a valuable lake trout or whitefish, lamprey have been blamed for the decline in these and other Great Lakes fish species. A single adult lamprey can be responsible for the death of up to 40 pounds of fish in its lifetime. An attack by a sea lamprey results in the death of six out of seven prey fish, directly by the loss of bodily fluids or from a secondary infection that occurs at the wound site. Fish that survive lamprey attacks are weakened and are more vulnerable to future attacks by lampreys or capture by more powerful predators. Many anglers have caught a trout or salmon that displays one or several scars from previous lamprey attacks.

Adult lampreys spawn in the Spring and Summer on gravel beds in Great Lakes tributaries, dying upon laying their eggs. After hatching, small worm-like lamprey larvae drift downstream and burrow into sand and silt, where they live on algae and detritus until they emerge some four to six years later as six inch parasites. They then swim downstream to the Great Lakes where they begin feeding on their fish hosts.

The binational Great Lakes Fishery Commission relies on constructed stream barriers that don't interfere with the passage of other fish species, and the use of chemical lampricide treatments in spawning streams around the Great Lakes to control lamprey populations. The lampricide treatments have proven to be very effective, but are quite costly – each year, millions of dollars are spent for lampricide treatments. An innovative male catch-sterilization-and-release program has also been used to reduce populations. Unfortunately, as many of the environmental conditions of tributaries surrounding the Great Lakes improve, new habitat is created for sea lamprey. Research continues on alternative lamprey control methods, including the innovative use of pheromone attractants that could be used to draw sea lamprey into traps or towards unsuitable stream spawning sites. Despite treatments, sea lamprey populations remain strong in a number of locations around the Great Lakes.

Alewife (*Alosa pseudoharengus*)

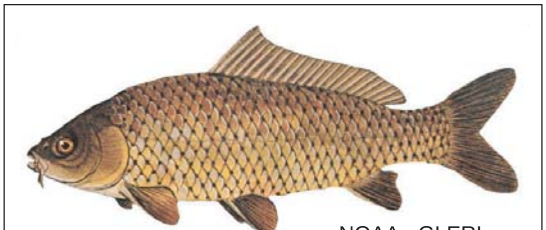


Alewives, a small, silvery fish, were first discovered in Lake Ontario in 1873. It is unclear whether they were native to Lake Ontario, or expanded their range through the Erie Canal into the Great Lakes Basin from the Atlantic drainage. If they were, in fact, native to Lake Ontario, their populations must have been controlled by Atlantic salmon and lake trout until the late 1800s. It is also theorized that the alewife may have actually been stocked into the lake accidentally, misidentified as juvenile shad (the two look very similar in their early life stages).

Alewives have proven themselves to be superior competitors to native fish because they are able to out-compete fishes like lake herring, bloaters, and whitefish for food. They also feed readily on young of native fish species, including lake trout, yellow perch, walleye and whitefish. The alewife population in Lake Erie and Lake Ontario has become the primary food resource of adult Pacific salmon and lake trout.

In the absence of predators, alewives have the ability to dramatically increase their population levels to unnaturally high levels, often resulting in huge die-offs that foul beaches. Alewives are also very sensitive to cold water temperatures, and die-offs typically occur during extreme winters or when there are upwellings of colder bottom waters in the lakes. This trait makes alewives an unstable, albeit nutritious, food resource for salmon and trout.

Common carp (*Cyprinus carpio*)



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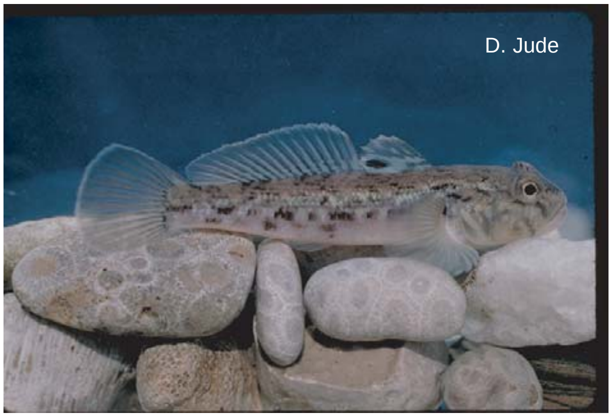
The common carp, found in the Great Lakes today, comes from the Caspian Sea and parts of Asia. The carp was originally stocked in the basin in the late 1800s by the U.S. Fish Commission as a source of “cheap” food for the future (carp quickly fell out of favor as a food species). The fish were commonly stocked in farm ponds where they often escaped into nearby ecosystems during periods of flooding. Once released into the Great Lakes Basin, carp spread quickly and easily – in fact, the common carp can now be found in every state in the continental U.S.

The common carp is a very hardy fish, capable of surviving in less than optimal habitats. As a result of their feeding behavior (they pull out plants and root around in the bed of lakes and streams) they degrade lakes by causing excessive turbidity (cloudiness caused by disturbed silt), which can lead to declines in submerged aquatic plants and organisms, waterfowl, and important native fish species.

Common carp are also prolific breeders, inflicting substantial competion for habitat on other, more desirable species. It is also hypothesized that common carp prey on the eggs of other, native, fish species, reducing breeding stocks of native populations. Carp have a remarkable ability to negatively alter their aquatic environment and are generally considered a nuisance species wherever they occur.

Round Goby (*Neogobius melanostomus*)



One of the newest invasive fish species in the Great Lakes, the round goby, is an aggressive fish that out-competes native fish such as sculpins for food and territory. Originally from the Black and Caspian Seas region, round gobies were first discovered in the Great Lakes (St. Clair River) in 1990, by Dr. David Jude of the University of Michigan. These benthic fish have a highly developed sensory system that allows them to find food and avoid predation much better than the native species with which they are competing. Round gobies are also capable of feeding at night, which gives them an advantage over many native fish that are restricted to feeding when light is present.

In addition to their aggressive nature and adaptive behaviors, round gobies are also capable of spawning several times each year. Males grow larger than females and the males guard the nests filled with eggs. This parental care helps to reduce predation on the eggs and increase survival rates. These reproductive strategies have helped round goby populations proliferate throughout the Great Lakes basin.

Although some people see the zebra mussel-eating goby as a beneficial invader, some researchers are concerned that gobies may move the contaminants found in the flesh of zebra mussels (bioaccumulated their as a result of the mussels' voracious filter feeding) up the food chain, where the toxins have the potential to impact valuable game fish such as smallmouth bass. Research continues on this link between round gobies and toxins from zebra and quagga mussels. There may also be a zebra mussel - round goby link to the recent outbreak of avian botulism plaguing Lake Erie.

Purple loosestrife (*Lythrum salicaria*)

When European settlers moved to the Great Lakes region, they brought with them a number of familiar plants. These included useful species for use as food (both for humans and for livestock), decoration (flowers), and medicinal purposes. Unfortunately, some of the plants that migrated along with the early settlers have also proven to be detrimental to the health of the Great Lakes ecosystem. Included in this group is purple loosestrife. This emergent aquatic plant, a native of Eurasia, was first introduced into North America in the early 1800s, most likely as both an ornamental plant and a medicinal herb, and as a stowaway in the form of seeds in the solid (soil) ballast used to stabilize ships making trans-Atlantic crossings in that era. Seeds were also probably mixed in with the fodder and bedding that the settlers brought with them for their [imported] livestock. The plant is also favored by American beekeepers for the production of honey. By the late-1800s, purple loosestrife was found throughout much of the northeastern portion of the United States and southeastern Canada. The construction of the Erie Canal (and numerous other regional canals in the mid- and late-1800s) opened most of the Great Lakes Basin to loosestrife colonization by the end of the 19th century. Today, loosestrife can be found in every continental state except Alaska and Florida. In the 1930s, purple loosestrife began to aggressively colonize St. Lawrence River flood plains; it has since become a major nuisance plant in most of its North American range.

Purple loosestrife is a very aggressive colonial plant. One mature plant can produce more than a million seeds per growing season; the plant can also be established from stem or root fragments. Loosestrife seeds are known to be spread in the feathers and fur of birds and other wildlife that have been up against the plants. Seeds and plant parts can also be spread by wind, river and stream flow, floods, and mixed in with soil and vegetation disturbed by development activities. Purple loosestrife is generally thought of as a colonizer of disturbed habitats (the disturbance stresses local vegetation populations and gives loosestrife a competitive advantage over slower growing native plants). The plant has also, however, been found to be able to slowly colonize undisturbed areas and drier lands, creating an emerging threat to agriculture and damaging crop and pasture land productivity.

Once purple loosestrife becomes established in a wetland, it can out compete native vegetation such as cattails, sedges and rushes, and can form monospecific stands in which as much as half of the native wetland vegetation biomass can be displaced. Loosestrife has little value as a food source for waterfowl and wetland animals, and dense stands of loosestrife can eliminate the cover value of native vegetation. The loss of native vegetation can result in the loss of the native wetland wildlife, as well. Loosestrife can also reduce the productivity of shallow waters utilized as spawning habitat for native fish. Some stands of loosestrife in shallow waters can even be thick enough as to block the passage of small boats.

Small, newly introduced patches of purple loosestrife can be controlled by hand pulling, by treatment with broad-spectrum herbicides, or by flooding. Such control methods are generally ineffective or too costly or physically difficult to be used against well-established stands of the plant. Mowing is not effective since new plants can be established from stem fragments; burning is ineffective unless the fire is intense enough to kill the plant's roots. Although more than 100 species of insect feed on purple loosestrife in its native range, no North American insects have been found to parasitize the plant. Such insects serve to keep loosestrife from becoming the dominant plant in its native range. Years of research into control of loosestrife by insect predation has resulted in five species of insect being approved as biological control agents, including a root-mining weevil, two leaf-eating beetles (*G. calmariensis*, shown at left), a flower-feeding weevil and a seed-feeding weevil. While more study of bio-control remains to be done, initial results at such test locations as the Montezuma National Wildlife Refuge have been very positive.

Water Chestnut (*Trapa natans*)

The water chestnut is a rooted, invasive aquatic plant that has both floating and submersed leaves. It was first introduced to North America around 1874 as a water garden plant and for the food and medicinal value of its four-horned, nut-like fruit. The first record of the plant growing wild was in the Charles River (Massachusetts) in 1879. The first Great Lakes Basin introduction of water chestnut was in Collins Lake (near Scotia, New York) around 1884. Since then, the plant has spread to other waters in New York and the Northeast. During the past twenty years, water chestnut has spread throughout central New York via the interconnected river/NYS barge canal system from Cross Lake to Oneida Lake and into the Oswego River Corridor. *Trapa* has been found along the south shore of Lake Ontario in Sodus Bay since the 1960s. It can also be found in New York's Hudson and Mohawk Rivers and in the Lake Champlain watershed.

Water chestnut grows in freshwater lakes and ponds, as well as in slow moving streams and rivers. It prefers shallow, calm, nutrient-rich waters, where its cord-like stems can reach lengths of up to 16 feet. The plant is a fierce competitor when growing in shallow waters that have soft, muddy bottoms. If uncontrolled, water chestnut can develop nearly impenetrable mats across wide areas of water, creating a hazard for boaters. Thick growths of the plant can severely limit light penetration into the water. The floating canopy of vegetation shades the floor of the waterbody, cutting off sunlight to native plants and degrading the natural functioning of aquatic ecosystems. Dramatic drops in dissolved oxygen content of infested waterbodies have been observed, apparently due to such shading of native vegetation. This can potentially contribute to fish kills. Water chestnut also out competes native vegetation, is of little food value to wildfowl and wildlife, and may diminish native species use of an invaded area. The sharp spiny nuts can be physically hazardous to swimmers walking on the bed of an infested waterway.

Water chestnut control general consists of mechanical harvesting of the floating mats using weed harvesters or hand pulling from canoes or kayaks. Repetitive harvesting of small areas of lwaterbodies can be effective at controlling water chestnut populations but, unless all of the plants, including root structure, is removed, regrowth will often take place after termination of harvesting activities, providing only a short-term solution.

Not only does the management of water chestnut result in the expenditure of public and private funds, but the presence of water chestnut in a lake or river can seriously harm property values along the infested areas as the use of the water resource is degraded. It has been shown that invasive plants can degrade shoreline property values by more than $12,000 per lot along heavily infested portions of lakes and rivers.

Invasive plant experts believe that the spread of water chestnut can be slowed and existing infestations managed by aggressive public education programs in addition to mechanical harvesting and hand pulling.

Eurasian Watermilfoil (*Myriophyllum spicatum* L.)

Eurasian watermilfoil, a rooted aquatic weed native to Europe and Asia, has become one of the most widely dispersed invasive aquatic plants. It can now be found in 45 states and three Canadian provinces. Milfoil was first identified in a pond in the Washington, DC, are in 1942. It is believed to have been introduced into the United States intentionally, most likely as a water garden and aquarium plant. It was introduced into ponds and streams across the county by intentional plants. Colonies spread in place by stolons (stemlike branches). New milfoil plants typically grow from small fragments and the plant is quickly spread throughout connected waters via currents. Recreational boats and harvesting activities are major causes of milfoil fragmentation and distribution throughout waterbodies. Milfoil fragments can also be transported from infested to uninfested waterways on trailered boating equipment.

Milfoil will colonize shallow areas of lakes and ponds, and low energy areas of rivers and streams. It has a particular competitive advantage in disturbed waterbodies such as those with excessive nutrient loading, high levels of recreational boat use, or substantial physical disruption. Milfoil exhibits very rapid growth (reaching the surface in waters as deep as 20 feet in a single season), starting earlier in the spring growth than native aquatic plants and quickly reaching the surface. The plant forms dense vegetative canopies that shade the native vegetation, resulting in a decline of both native plant abundance and diversity. Milfoil has little value as a waterfowl food source, and a high densities can reduce the abundance and diversity of invertebrates which serve as food for fish. Dense beds of milfoil can impair recreational use of a waterbody, reduce fish spawning and foraging habitat, and out compete native vegetation. The die off of old milfoil can deplete dissolved oxygen levels in a waterbody. Dense milfoil populations can restrict boating, fishing and swimming, and can become uprooted and foul beaches.

Generally speaking, there is no way to completely eradicate Eurasian watermilfoil once it has become established in a waterbody. Because it is not indigenous to North America, this weed has no natural biological controls (such as insects or microbes) that would hold down its populations in its native range. Stakeholders can help minimize the spread of Eurasian watermilfoil by ensuring that all fragments of the plant are removed from boats and trailers before leaving infested waters, disposing of the fragments in the garbage or on dry land where they cannot be moved into any streams or lakes. Environmentally friendly controls include bottom barriers, suction harvesting, hand pulling (of small, new infestations), and raking the lake bottom to remove roots, stems, and fragments. Mechanical harvesting does not remove the roots, and can be considered as only a temporary reduction in the amount of vegetative material (much like mowing a lawn).

The Future Outlook

It is hoped that governmental agencies in the U.S. and Canada will continue their efforts to prevent new invasive aquatic species from entering the Great Lakes. Ballast water management efforts (mainly exchange of freshwater ballast for saltwater ballast 200 miles offshore prior to entry into the St. Lawrence River) are already underway but have not yet proven to be totally effective at keeping out new invaders. New technologies for ballast water management are being researched. Stakeholders need to become aware of this biological pollution and join in efforts to limit the introduction and spread of invasive organisms. Simple actions like inspecting and cleaning boats and trailers, eliminating bait bucket transfers and stopping the

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introduction of plants and animals from home aquariums, will do a great deal to reduce the spread of invasive aquatic species.

Whether intentional or accidental, the introduction of invasive species has had both an economic and ecological impact on the Great Lakes. As stakeholders, we must take steps to reduce the spread of invasive species and become informed about these species. Education and outreach are important elements, along with research, monitoring, and management that must be utilized in the battle to stop the spread and mitigate the impacts of invasive nonindigenous species on our environment.

Other Invasive Species in (and Coming to) Lakes Erie & Ontario

Blueback herring (*Alosa aestivalis*) - Ontario only

Asian clam (*Corbicula fluminea*)

New Zealand mud snail (*Potamopyrgus antipodarum*) - Ontario only

Killer shrimp (*Dikerogammarus vilosus*) - Potential

Ponto-Caspian amphipod (*Echinogammarus ischnus*)

Eurasian ruffe (*Gymnocephalus cernuus*) - Potential

Tube-nosed goby (*Proterorhinus marmoratus*) - Potential

Rudd (*Scardinius erythrophthalmus*)

Additional Information

The following web sites provide information on invasive aquatic species:

National Aquatic Nuisance Species Clearinghouse: http://www.aquaticinvaders.org

Sea Grant Nonindigenous Species: http://www.sgnis.org/

U.S. Fish and Wildlife Service Invasive Species Program: http://nas.er.usgs.gov/

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