Classroom Guide

Contents

How to use the ATTACK PACK

This backpack includes background material, information about some of the aquatic invaders in the Great Lakes, preserved specimens to examine and a USB flash drive containing ten classroom activities developed by the Great Lakes Sea Grant Network.

The preserved specimens included in the **Attack Pack** are all nontoxic, and you are encouraged to open the plastic bag and handle the sea lamprey specimen directly. To keep the lamprey moist, please seal it in the provided resealable plastic bag at the end of your class.

When your class is finished using the Attack Pack, please return it after repacking the background material, flash drive and all of the preserved specimens so that they are available for other classrooms that borrow the pack in the future. The wallet-size watch cards are yours to keep for your classroom.

ATTACK PACK materials

- This Attack Pack Classroom Guide with background information and instructions
- Aquatic invasive species fact sheets
- Preserved specimens: sea lamprey, zebra mussel, quagga mussel, round goby, rusty crayfish, Eurasian ruffe, fishhook waterflea and silver carp
- Invasive plants booklet
- Attack Pack carabiner flash drive containing lesson plans
- Brochures and identification watch cards

www.iiseagrant.org/NabInvader

Nab the Aquatic Invader!

The Attack Pack complements the **Nab the Aquatic Invader!** website, which provides the most relevant and current information about aquatic invasive species, their modes of entry and their impacts. The website is designed for students in grades 4-10, and it is aligned with National Science Education Standards.

After selecting the Great Lakes region, students become detectives investigating crimes committed by the 10 most wanted aquatic invaders. The resources teach young detectives about crimes committed by these invaders and help students book the "bad guys" as they take on various cases (hands-on activities). "Nab those menacing invaders" poster sets and game cards are also available to order from the Top Desk Administrator page.

The Nab! site offers hundreds of teaching tools, with multi-disciplinary activities that integrate science, geography, math and language arts. The student activities were developed by teachers, so they are practical and proven for the classroom. The site provides many opportunities for problem-based learning, critical thinking and scientific inquiry. It's also a fun way to learn about aquatic invasive species in the Great Lakes!

Lesson plans on flash drive

Who Are the Exotic Invaders?

Grades K and 6 (cooperatively)

Sixth-grade students learn about exotic species and then instruct kindergarten students. Sixth-graders prepare games and a mural to use with the younger students. (Any combination of primary and upper elementary students could use this activity.)

Beware! Invaders!

Grades 2–5

Because music can help students learn in a different way, this activity uses a song to supplement and reinforce lessons about aquatic invasive species.

Invader Species of the Great Lakes

Grades 4–6

Students do a card-matching activity to learn about exotic species. In groups, students select an aquatic invader, create a poster or fact sheet and develop a charade-like game to demonstrate ways to prevent exotic species from spreading.

Seeing Purple

Grades 4–8

Through a simulation, sampling and estimation activity, students learn about the effects of purple loosestrife on a wetland due to its exponential growth. They learn about purple loosestrife's life cycle and appreciate how scientists determine population size in an ecosystem.

Great Lakes Most Unwanted

Grades 4–8

Students work in small groups to organize invasive species watch cards that feature facts and photos. Each group presents a different aquatic invasive species in a poster or fact sheet to the class.

Ruffe Musical Chairs

Grades 4–8

Students use role-play to mimic the behavior of an invasive, non-native fish called Eurasian ruffe (pronounced "rough") to experience firsthand how and why the species has multiplied so rapidly in some Great Lakes harbors.

Don't Stop for Hitchhikers!

Grades 4–8

Students role-play the part of native aquatic species and the aquatic invaders that displace them. Props are used to help demonstrate how aquatic invasive species enter the lake or river system, the negative effect they have on the native species and things people can do to stop the spread of aquatic invaders.

Beat the Barriers

Grades 4–8

This board game teaches students about the various methods used to limit the sea lamprey population in the Great Lakes. Students assume the identity of sea lampreys and attempt to migrate from Lake Ontario to Lake Superior.

Rival for Survival

Grades 6–9

This game presents real-life choices involving aquatic invasive species found in the Great Lakes, such as zebra mussels and purple loosestrife. Students analyze a situation related to ecology and make an environmentally sound decision. After playing the game, students organize what they learned into a concept map.

Great Lakes Grief

Grades 5–12

Students create a flyer in a newspaper format for distribution at local supermarkets, which gives them the opportunity to experience a community stewardship campaign.

What are aquatic invasive species?

What are aquatic invasive species?

Aquatic invaders, also known as aquatic invasive species, are plants, animals and pathogens that have been introduced into new environments, have reproduced and spread rapidly, and now threaten native species. Aquatic invasives can also limit recreation opportunities, increase business costs and threaten human health.

To date, more than 180 nonnative species have established themselves in the Great Lakes, causing billions of dollars in damages and control measures each year. Public awareness and actions are essential to preventing even more invasions, as eliminating aquatic invasive species after they've established themselves is usually impossible.

All organisms need adequate food and habitat in order to survive and reproduce. That said, introducing nonnative species to a new ecosystem does not necessarily mean they will become established there. For example, sometimes a population may be too sparse to be viable. In other cases, the climate and temperature may not be well suited to the introduced species. However, in their new ecosystems, nonnative species are usually removed from the predators, parasites, pathogens and competitors from their natural range. Without these pressures, they can have high rates of survival and reproduction, allowing them to spread quickly and easily drive out native species. This is when nonnative species become invasive species.

Why are they a problem?

Some aquatic invasive species, such as sea lampreys and certain viruses, can harm or kill native species directly, while others outcompete native species for resources. Every ecosystem has a limited amount of resources available to organisms living there, and adding new organisms to an ecosystem means that native organisms now have more competition for food and shelter, or they might be targeted by a new predator. Invasive species have caused the extinction of native species,

Dave Jude/University of Michigan

Zebra mussels invaded the Great Lakes in 1988.

especially those in confined habitats such as island and aquatic ecosystems.

Aquatic invasive species can affect people as well. First, they can limit recreational opportunities such as fishing or swimming, as well as lower waterfront property values. Also, they can harm businesses such as commercial fishing, water utilities and commercial shipping financially. These economic losses are difficult to quantify in the states making up the Great Lakes region. However, such losses have been estimated to be as high as $100 million per year in 2012 (USD).

Organisms invading the Great Lakes can also threaten public health by carrying disease, concentrating pollutants, contaminating drinking water and causing other harmful human health effects.

How did they become a problem?

The rate of invasive species introductions has increased along with the increase in global trade that has occurred over the last several decades. As our trade with foreign countries increases, so does the risk and the rate of nonnative species introductions.

There are four main reasons why aquatic invasive species have been able to enter and establish themselves in our Great Lakes waters: improvements in water quality, development of larger and faster transatlantic vessels, removal of natural barriers and intentional or accidental introduction.

Water quality

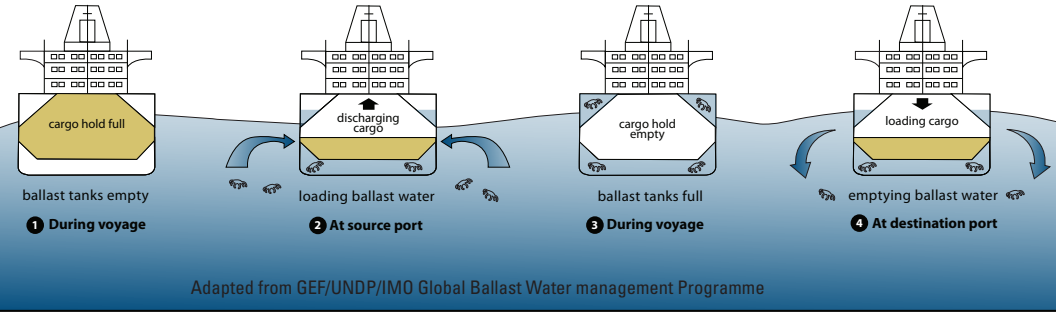
Before the 1970s, many harbors were very polluted. In fact, the Cuyahoga River—which flows through Cleveland, Ohio, and into Lake Erie—caught fire several times because it was so heavily polluted with oil and debris. Very few organisms could live in such an environment. Over the last few decades, regulations like the Great Lakes Water Quality Agreement and the Clean Water Act reduced pollution in inland and coastal harbors. As a result, the habitat quality of the harbors greatly improved, allowing all sorts of organisms to thrive—both native and nonnative.

Transatlantic trade

Ships moving in and out of these cleaner harbors are responsible for many of the aquatic invasive species causing problems in the Great Lakes. Many of these invaders hitched a ride inside the ships in what is known as "ballast water."

When large ocean-going ships sail without cargo, tanks in their hulls are filled with water to stabilize them at sea. Then the ships travel across the ocean, exchanging cargo for ballast water and vice versa. Before certain regulations were established, anything living in that ballast water was transported across the ocean into a new environment. Many aquatic

Modern ocean-going ships take on water as ballast to stabilize them when they travel without cargo. Many invasive species, such as the zebra mussel, European ruffe and round goby, came to the Great Lakes in ballast water from foreign ports.



Adapted from GEF/UNDP/IMO Global Ballast Water management Programme

invasive species have made their way from foreign countries to the Great Lakes in ballast water.

Natural barriers

Removing natural geographic barriers by constructing locks and canals has also allowed aquatic invasive species to enter the Great Lakes. Natural barriers such as Niagara Falls blocked upstream migration of Atlantic Coast species until the Welland Canal opened in 1829 as a way for Great Lakes ships to bypass the falls. In 1919 it was upgraded to allow large, ocean-going vessels to enter Lake Erie from the St. Lawrence River and the Atlantic Ocean. However, ships weren't the only things to take advantage of the canal. Atlantic species like sea lampreys, alewives and white perch also took the opportunity to enter the upper Great Lakes.

The Chicago Sanitary and Shipping Canal is another artificial waterway providing a route for invasive species to enter, and exit, the Great Lakes. More than 100 years ago, the city of Chicago flushed its sewage into the Chicago River and out to Lake Michigan. However, Lake Michigan was, and still is, the source of drinking water for the city, and many people died of cholera, typhoid or other waterborne illnesses. To avoid this problem, the city of Chicago opened the Chicago Sanitary and Shipping Canal in 1910 in order to divert its sewage from Lake Michigan. This permanently reversed the flow of the Chicago

Invasive species like the sea lamprey entered the Great Lakes when the Welland Canal was constructed to bypass Niagara Falls. Sea lampreys are parasitic pests. They attach to fish with their suction mouth and teeth, and they use their tongues to rasp through a fish's scales and skin so they can feed on its blood and body fluids. A single sea lamprey will destroy up to 40 lbs. of fish during its adult lifetime.

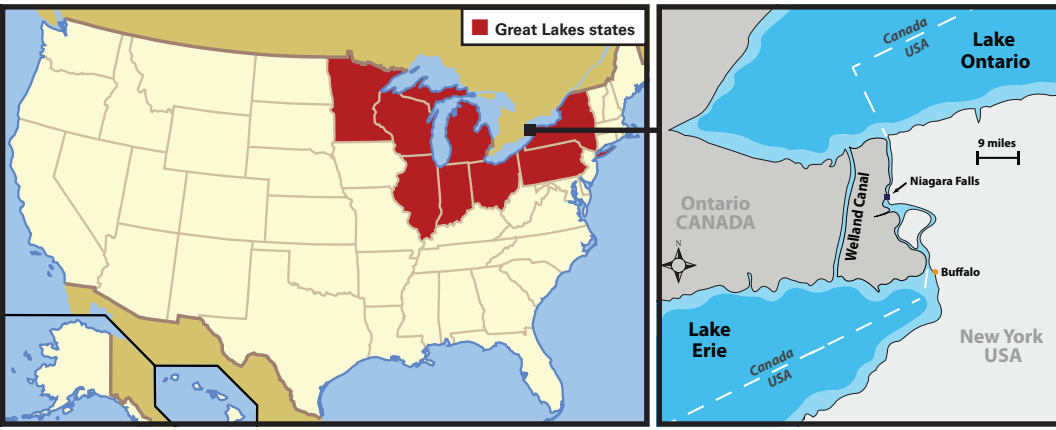
River. Instead of flowing into Lake Michigan, the Chicago River now flows out of Lake Michigan, connecting to the Mississipi River via the Des Plaines and Illinois Rivers.

Historically, heavy pollution prevented many species from living in the canal. However, water quality has improved greatly over the last few decades, and today the canal is a potential two-way street for aquatic invasive species. For example, zebra mussels flowed downstream to the Mississippi River from the Great Lakes, and Asian carp swimming upstream from the Mississippi River are threatening to enter the Great Lakes.

Intentional or accidental release

Finally, humans released some aquatic invasive species into the Great Lakes, either intentionally or accidentally. For example, in the 1960s, state fishery managers began stocking Pacific salmon in the Great Lakes to control alewives, an invasive fish that entered the Great Lakes from the Atlantic Ocean through the Welland Canal. Today, Pacific salmon and alewives have become part of the Great Lakes food web, and they help support a sport fishery valued at $7 billion annually in U.S. waters.

While Pacific salmon were intentionally introduced to the Great Lakes, the invasive plant Brazilian elodea was probably introduced by accident. It is a popular aquarium plant that was likely released into the wild after being discarded. Brazilian



elodea can spread 100 acres a year, smothering out native plants and clogging waterways.

How they spread

Once a nonnative organism is introduced to the Great Lakes, it can quickly spread to inland lakes and rivers by hitching a ride on watercraft, trailers and fishing and other recreational equipment, as well as by anglers releasing unwanted bait into lakes and rivers.

What can be done?

Aquatic invasive species can be considered biological pollutants. Like most pollution, they are easiest to manage through prevention. Once released into the environment they are very difficult to eliminate. The first objective is to prevent their introduction. After a species is introduced, regulation and education are the primary ways to prevent its spread. Reporting sightings of aquatic invasive species to state natural resources agencies is critical to identifying new populations.

Ballast water is the source of at least 55 percent of reported aquatic invasive species introductions in the Great Lakes since 1959. Since 2006, the Canadian and U.S. governments have required ships entering the Great Lakes to take several steps to eliminate aquatic invasive species from their ballast water.

The silver carp (right) is one species of Asian carp that is now established in the Mississippi River basin and could become established in the Great Lakes by entering through the Chicago Sanitary and Ship Canal system. Silver carp jump into the air when startled by boat engine noise, and some have seriously injured boaters. All Asian carp (silver, bighead, black and grass carp) are voracious eaters and could seriously deplete the amount of food available for native fish in the Great Lakes.

First, ships must empty their ballast water in the middle of the ocean and refill with sea water, a process called ballast water exchange. As an extra precaution, ships are also checked to make sure that the salinity (amount of salt) of the water in their ballast tanks is high enough to kill organisms from their original port. These steps have reduced the number of invasive species entering the Great Lakes. However, ballast tanks usually do not completely empty; some water is often left behind. Also, high salinity doesn't always kill all organisms. New technologies are being developed to address these issues.

Steps have also been taken to limit introductions of invasive species through waterways that have been altered by humans. In 2002, the U.S. Army Corps of Engineers constructed an electric barrier across the Chicago Sanitary and Shipping Canal. Its original purpose was to prevent fish like the Eurasian ruffe and the round goby that had invaded the Great Lakes from swimming into the Mississippi River. Today, the barrier has become important in trying to keep the Great Lakes free of Asian carp, invasive fish that have been making their way up the Mississippi River after being intentionally released or escaping from southern fish farms, sewage lagoons and research facilities. The barrier sends an electric current through the water that makes fish uncomfortable and causes them to swim away. However, the barrier can never be 100 percent effective in blocking invasive species because it doesn't prevent small planktonic organisms or viruses from moving through

the canal. Ultimately, the Great Lakes and the Mississippi River may need to be permanently separated again in order to prevent the movement of aquatic invasive species between the two ecosystems.

To prevent introductions of aquatic invasive species by aquarium owners, gardners and farmers, the federal government regulates which animals and plants can be brought into the U.S. for aquaria, water gardens, aquaculture and horticulture. However, sometimes people ignore these regulations intentionally or unintentionally, and the organisms appear for sale in stores, catalogues and on the Internet. Often people are unaware of the problems these organisms can cause if they are released into the wild.

How Can I Help?

Everyone can help stop aquatic invasive species. If you are studying live specimens in your classroom, or if you have acquired an unwanted aquatic plant or fish species for your aquarium or water garden, it is important not to release these plants or animals into the environment. Habitattitude™ (**www.habitattitude.net**) is a national campaign to educate consumers about alternatives to releasing these organisms, such as:

- Contact the retailer for proper handling advice or for possible returns.
- Give or trade unwanted plants and animals with another classroom, aquarist, pond owner, or water gardener.
- Seal aquatic plants in plastic bags and dispose in trash.
- Contact a veterinarian or pet retailer for guidance about humane disposal of animals.

If you enjoy fishing or boating, the nationwide Stop Aquatic Hitchhikers!™ campaign (**www.protectyourwaters.net**) urges you to help prevent aquatic invaders from spreading to new bodies of water by following these four simple steps:

- Remove any visible mud, plants, fish or animals before transporting equipment.
- Drain water from equipment before transporting.
- Clean and dry anything that came in contact with water (boats, trailers, equipment, clothing, etc.).
- Never release plants, fish or animals into a body of water.

Wisconsin Sea Grant Institute

The photo above shows the location of one of the electric barriers in the Chicago Sanitary and Shipping Canal. Since the first barrier was constructed in 2002, the U.S. Army Corps of Engineers constructed two additional electric barriers within the canal. Barges can safely pass through the barriers, but the large red sign in the upper photo warns recreational boaters and swimmers to avoid the areas.

Resources

Stop Aquatic Hitchhikers!™

www.protectyourwaters.net

This site informs recreational water users how to prevent the spread of aquatic invasive species.

Habitattitude™

www.habitattitude.net

This site teaches aquarium hobbyists, backyard pond owners, water gardeners, teachers and students not to release unwanted fish and aquatic plants into the wild.

Aquatic Invasive Species: Then and Now

www.ijc.org/rel/ais-timeline

This website features an interactive timeline of key events, discoveries and policy changes regarding aquatic invasive species in the Great Lakes.

Maps of Current AIS Locations

www.iiseagrant.org/NabInvader/great_lakes.html

These maps showing the locations of dozens of aquatic invaders are frequently updated by the United States Geological Survey. Click on "Top Desk Administrator" and then "Maps."

Preventing the Spread of Aquatic Invasive Species

(Music with a Message)

www.uwex.edu/erc/music

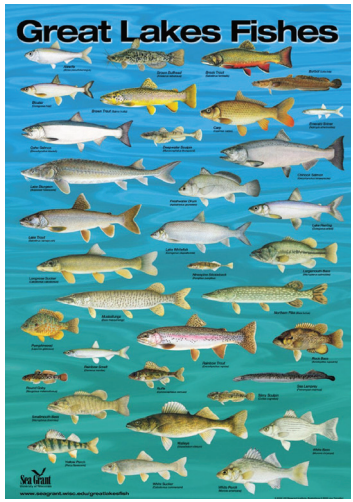
Research shows music can influence how people respond to messages, influencing memory and recall, emotion, information processing, attitudes and even behavior. A group of singer/songwriters produced these songs to promote behaviors to help prevent the spread of aquatic invasive species in Wisconsin and beyond.

Additional Resources to Order for Your Classroom

Great Lakes Fishes Poster

aqua.wisc.edu/publications

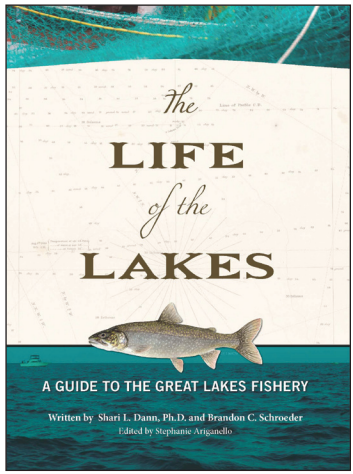
This colorful poster features beautiful and highly accurate illustrations of 35 native and exotic Great Lakes fishes by famed wildlife artist Joseph R. Tomelleri.

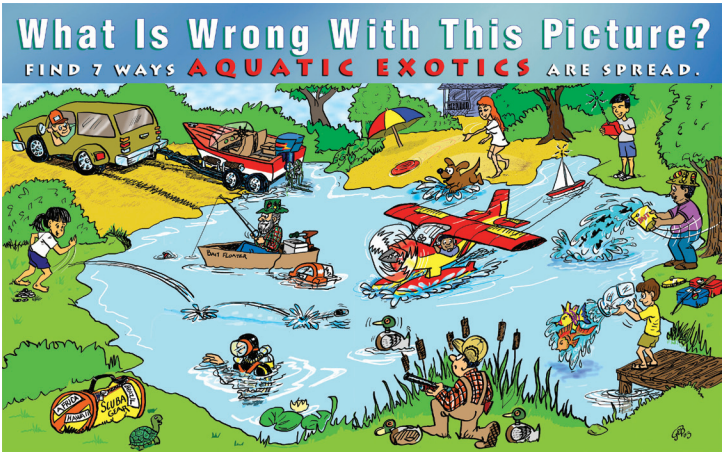


The Life of the Lakes

www.miseagrant.com

This book is written for anglers, educators, natural resource managers and anyone interested in Great Lakes issues. Now in its third edition, "The Life of the Lakes" continues to provide up-to-date information, focusing on the people, resources and fish that all play a part in the story.





Find 7 Ways Aquatic Exotics Are Spread

www.iisgcp.org/catalog/ed/7way.htm

Aquatic exotics (aquatic invasive species) can be introduced into new bodies of water through various human-made pathways. This eye-catching classroom tool teaches students a number of these pathways by challenging them to find typical people-related activities that pose potential problems.

Nab those Menacing Invaders! poster set

www.iisgcp.org/catalog/ed/nabpstr.htm

These fact-filled laminated posters will help students in grades 4–10 understand the effects of aquatic invasive species. Based on characters from the Nab the Aquatic Invader! website, **www.iiseagrant.org/NabInvader**, where these species are colorful crime suspects.

The Great Lakes Basin Map

www.miseagrant.com

This map includes a depth profile of the Great Lakes and major rivers within the system, shows the direction and volume of flow through each of the lakes, and illustrates the journey of water from Lake Superior out to the Atlantic Ocean. It was designed to be attractive as well as educational and is easy to use, which makes it great for the classroom or as a framed homage to the amazing Great Lakes.

Nab the Aquatic Invader! game cards

www.iisgcp.org/catalog/ed/nabcard.htm

Introduce your students to games such as "Invader Hide and Seek," "Exotic Species Recall" and "The Lonely Police Chief." This durable set of game cards for grades 4–10 provides a way to learn about aquatic invasive species. Based on the Nab the Aquatic Invader! website.

Great Lakes RESTORATION

Project of the Great Lakes Sea Grant Network based on a grant from the Great Lakes Restoration Initiative. **greatlakesrestoration.us**

Habitattitude™

PROTECT OUR ENVIRONMENT

DO NOT RELEASE FISH AND AQUATIC PLANTS

Sea Grant

Great Lakes Network

STOP AQUATIC HITCHHIKERS!™

Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

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seagrant.wisc.edu/attackpack

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